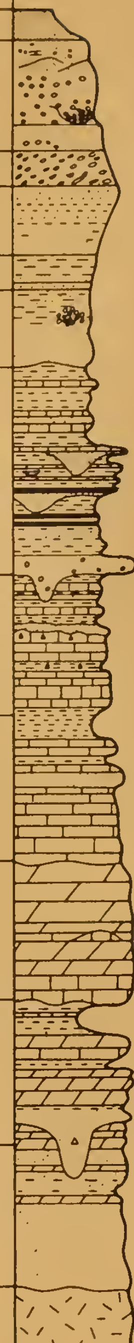
Geol Survey

Guide to the geology of the Nashville area, Washington County

D. L. Reinertsen, S. T. Whitaker, P. C. Reed, and L. R. Follmer

Field Trip Guidebook 1990D October 27, 1990
Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

Era		Period or System and Thickness	Epoch	Age (years ago)	General Types of Rocks
CENOZOIC "Recent Life"	Age of Mammals	Quaternary 0-500'	Holocene	10,000	Recent—alluvium in river valleys
			Pleistocene Glacial Age	1.6 m.	Glacial till, glacial outwash, gravel, sand, silt, lake deposits of clay and silt, loess and sand dunes ; covers nearly all of state except northwest corner and southern tip
		Tertiary 0-500'	Pliocene	5.3 m.	Chert gravel, present in northern, southern, and western Illinois
			Eocene	36.6 m. – 57.8 m.	Mostly micaceous sand with some silt and clay; present only in southern Illinois
			Paleocene	66.4 m.	Mostly clay, little sand; present only in southern Illinois
MESOZOIC "Middle Life"	Age of Reptiles	Cretaceous 0-300'		144 m. – 286 m.	Mostly sand, some thin beds of clay and, locally, gravel; present only in southern Illinois
PALEOZOIC "Ancient Life"	Age of Amphibians and Early Plants	Pennsylvanian 0-3,000' ("Coal Measures")		320 m.	Largely shale and sandstone with beds of coal, limestone, and clay
		Mississippian 0-3,500'		360 m.	Black and gray shale at base; middle zone of thick limestone that grades to siltstone, chert, and shale; upper zone of interbedded sandstone, shale, and limestone
	Age of Fishes	Devonian 0-1,500'		408 m.	Thick limestone, minor sandstones and shales; largely chert and cherty limestone in southern Illinois ; black shale at top
	Age of Invertebrates	Silurian 0-1,000'		438 m.	Principally dolomite and limestone
		Ordovician 500-2,000'		505 m.	Largely dolomite and limestone but contains sandstone, shale, and siltstone formations
		Cambrian 1,500-3,000'		570 m.	Chiefly sandstones with some dolomite and shale; exposed only in small areas in north-central Illinois
ARCHEOZOIC and PROTEROZOIC					Igneous and metamorphic rocks; known in Illinois only from deep wells



Generalized geologic column showing succession of rocks in Illinois.

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615 East Peabody Drive
Champaign, IL 61820

Geological Science Field Trips The Educational Extension Unit of the Illinois State Geological Survey conducts four free tours each year to acquaint the public with the rocks, mineral resources, and landscapes of various regions of the state and the geological processes that have led to their origin. Each trip is an all-day excursion through one or more Illinois counties. Frequent stops are made to explore interesting phenomena, explain the processes that shape our environment, discuss principles of earth science, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers who are or will be preparing earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for each ten students.

With this field trip program, we hope to stimulate a general interest in the geology of Illinois and a greater appreciation of the state's vast mineral resources and their importance to the economy. A list of earlier field trip guide leaflets for planning class tours and private outings may be obtained by contacting the Educational Extension Unit, Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820 (217) 244-2407 or 333-7372.

Please Note Some of the field trips are on private property. The owners have graciously given us permission to visit their lands on the day of the field trip, so please obey all instructions from the trip leaders and respect the property of the landowners. So that we may be welcome to return on future field trips, please do not litter or climb on fences, and leave all gates as you found them. (These simple rules of courtesy also apply to public property.) Because of trespass laws and liability constraints, any individuals or groups following this field trip guide at a later date *must* get permission from property owners or their agents before entering private property. On the day of the field trip, all participants *must* travel in the caravan.

Cover photo: Washington County State Conservation Area

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THE GEOLOGIC FRAMEWORK OF THE NASHVILLE AREA

The region covered on this field trip is in Washington County, slightly north-northwest of the center of southern Illinois. The Nashville area is some 265 miles so'uth-southwest of Chicago, nearly 50 miles southeast of St. Louis, and about 95 miles north-northwest of Cairo.

Bedrock

The geologic framework of the Washington County area has undergone many changes during several billion years of geologic time (see rock succession column on inside front cover). The oldest rocks beneath the field trip area belong to the ancient Precambrian "basement complex." We know relatively little about these rocks from direct observations because they are not exposed at the surface anywhere in Illinois. Only about 30 drill holes have reached deep enough in Illinois for geologists to collect samples from Precambrian rocks. From these samples, however, we know that these ancient rocks consist mostly of granitic igneous and possibly metamorphic, crystalline rocks formed about 1.5 to 1.0 billion years ago. These rocks, which were deeply weathered and eroded when they were exposed at the earth's surface up to about 0.6 billion years ago, formed a landscape that was probably quite similar to that of the present-day Missouri Ozarks. We have no rock record in Illinois for the long interval of weathering and erosion that lasted from the time the Precambrian rocks were formed until the Cambrian sediments accumulated—but the interval is almost as long as all of recorded geologic time from the Cambrian to the present.

Geologists seldom see Precambrian rocks except as cuttings from drill holes, but they can determine some of the characteristics of the basement complex through the use of various techniques. For example, evidence from surface mapping, measurements of the earth's gravitational and magnetic fields, and seismic exploration for oil indicate that in southernmost Illinois, near what is now the Kentucky-Illinois Fluorspar Mining District, rift valleys like those in east Africa formed as plate tectonic movements were beginning to rip apart the Precambrian North American continent. These rift valleys in the midcontinent region are referred to as the Rough Creek Graben and the Reelfoot Rift (fig. 1).

Near the beginning of the Paleozoic Era about 570 million years ago, the rifting stopped and the hilly Precambrian landscape began to sink slowly on a broad, regional scale, allowing the invasion of a shallow sea from the south and southwest. During the several hundred millions of years of the Paleozoic Era, the area that is now southern Illinois continued to accumulate sediments deposited in the shallow seas that repeatedly covered it. The region continued to sink until at least 15,000 feet of sedimentary strata were deposited. At times during this period the seas withdrew and the deposits were weathered and eroded. As a result, there are some gaps in the sedimentary record in Illinois. In the field trip area, bedrock strata are from about 523 million years old (the Cambrian Period) to 288 million years old (the Pennsylvanian Period). Figure 2 shows the succession of rock strata a drill bit would penetrate in this area if the rock record were complete and all the formations were present (the oldest formations are at the bottom right of the column).

Pennsylvanian-age bedrock strata consisting of sandstone, siltstone, shale, limestone, coal, and underclay, deposited as sediments in shallow seas and swamps between about 320 and 288 million years ago, are found immediately beneath a cover of glacial deposits. In the field trip area some of these rocks are exposed in scattered roadcuts and streamcuts. The thickness of Pennsylvanian strata increases from about 400 feet in northwestern Washington County to approximately 1,200 feet in the eastern part. Producing oil fields have been developed in

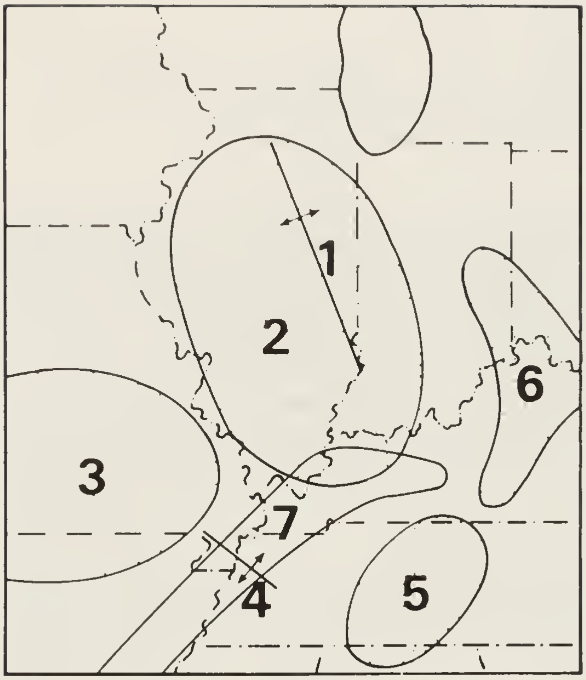


Figure 1 Locations of some of the major structures in the Illinois region: (1) La Salle Anticlinal Belt, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, (6) Cincinnati Arch, (7) Reelfoot Rift, SW to NE, and Rough Creek Graben, W to E.

Pennsylvanian sandstones in the northeastern part of the county. (See *Depositional History of the Pennsylvanian Rocks* at the back of this guidebook for a description of these rocks.)

In Washington County, Paleozoic sedimentary strata reach thicknesses of more than 6,200 feet in the northwest and about 9,400 feet in the southeast. Rocks of Ordovician, Devonian, Mississippian, and Pennsylvanian age have been successfully drilled for their petroleum resources in Washington County.

Structural and Depositional History

As noted previously, midcontinent rift valleys—the Rough Creek Graben and the Reelfoot Rift (figs. 1 and 3)—formed during Precambrian plate tectonic activity; later they filled with sands and gravels shed from the adjacent uplands and with sediments deposited in lakes that formed along the valley floors.

During the Paleozoic Era, sediments accumulated as the seas encroached on the landmass that now underlies Illinois and adjacent states. The earth's thin crust was frequently flexed and warped as stresses were built up in places. These worldwide movements caused changes in sea level that resulted in repeated invasions and withdrawals of the seas across the region. The former sea floors were thus periodically exposed to erosion that erased some sediments from the rock record.

Many of the sedimentary units, called formations, have conformable contacts—that is, no significant interruptions in deposition took place between formations (fig. 2). In some instances, even though the composition and appearance of the rocks change significantly at the contact between two formations, the fossils in the rocks and the relationships between the rocks at the contact indicate that deposition was essentially continuous. In some places, however, the lower formation was at least partly eroded away before the overlying formation was deposited, and fossils and other evidence in the two formations indicate that there was a significant gap between the time the lower unit was deposited and the time the overlying unit was laid down. This type of contact is called an unconformity. If the beds above and below an unconformity are

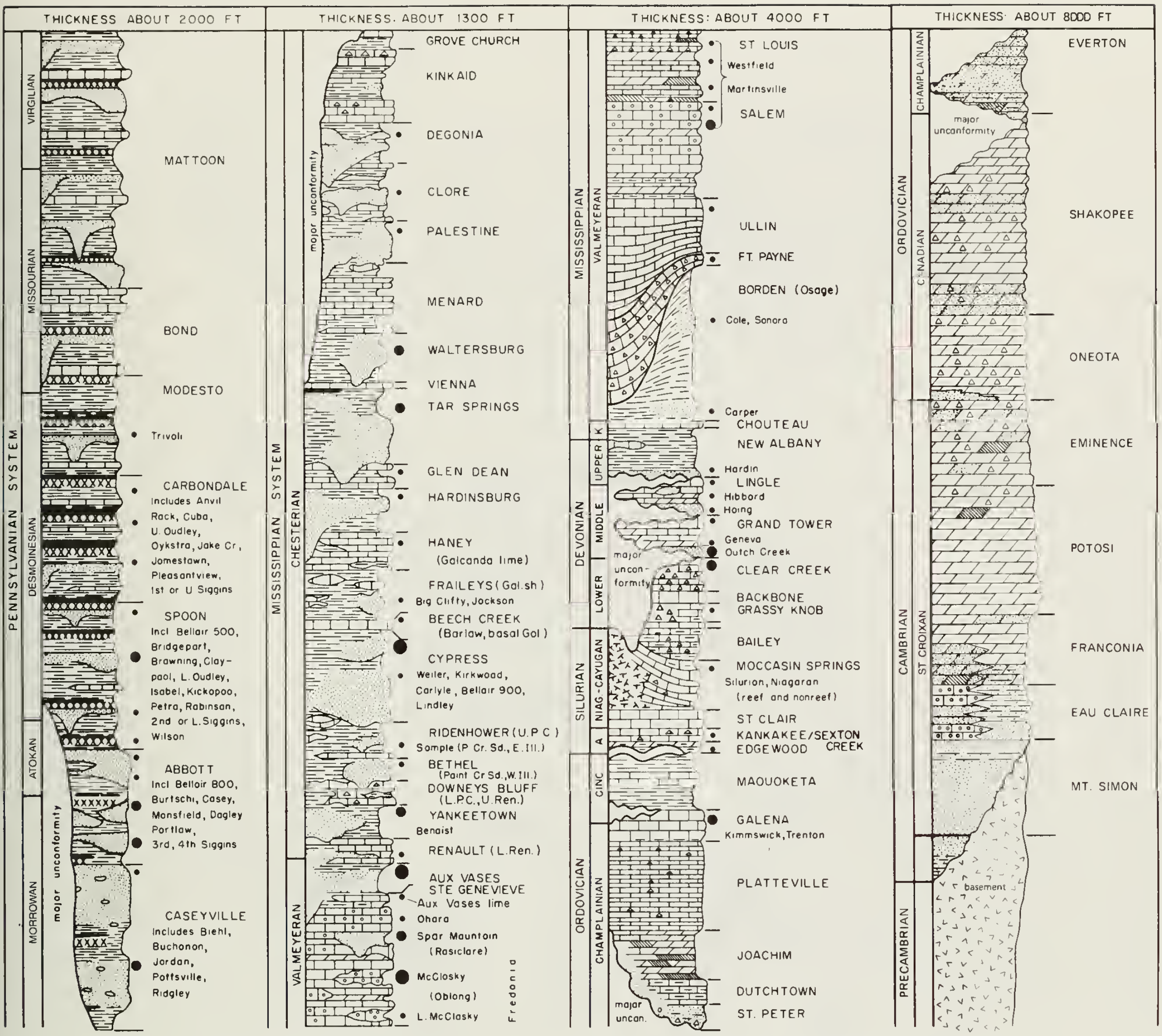


Figure 2 Generalized geologic column of southern Illinois. Black dots indicate oil and gas pay zones. Formation names are in capitals; other pay zones are not. About 4,000 feet of lower Ordovician and upper Cambrian rocks under the St. Peter are not shown. Kinderhookian (K), Niagaran (Niag.), Alexandrian (A), and Cincinnatian (Cinc.) Series are abbreviated. Variable vertical scale. Originally prepared by David H. Swann; modified from Illinois Geological Survey Illinois Petroleum 75.

parallel, the unconformity is called a disconformity; if the lower beds have been tilted and eroded before the overlying beds were deposited, the contact is called an angular unconformity. Three major unconformities are shown as undulating lines across the rock columns in figure 2. Each represents long intervals of time during which a considerable thickness of the rock record, known from other regions, is missing from parts of the area. Smaller unconformities also are shown in figure 2; these generally represent shorter time intervals or more local events than do the major unconformities, and at these points less material is missing from the record.

Near the close of the Mississippian Period (320 million years ago), gentle arching of the bedrock in eastern Illinois initiated the development of the La Salle Anticlinal Belt (figs. 1 and 4). An anticline is a term for a buried hill or dome in which rock layers have been bent into an

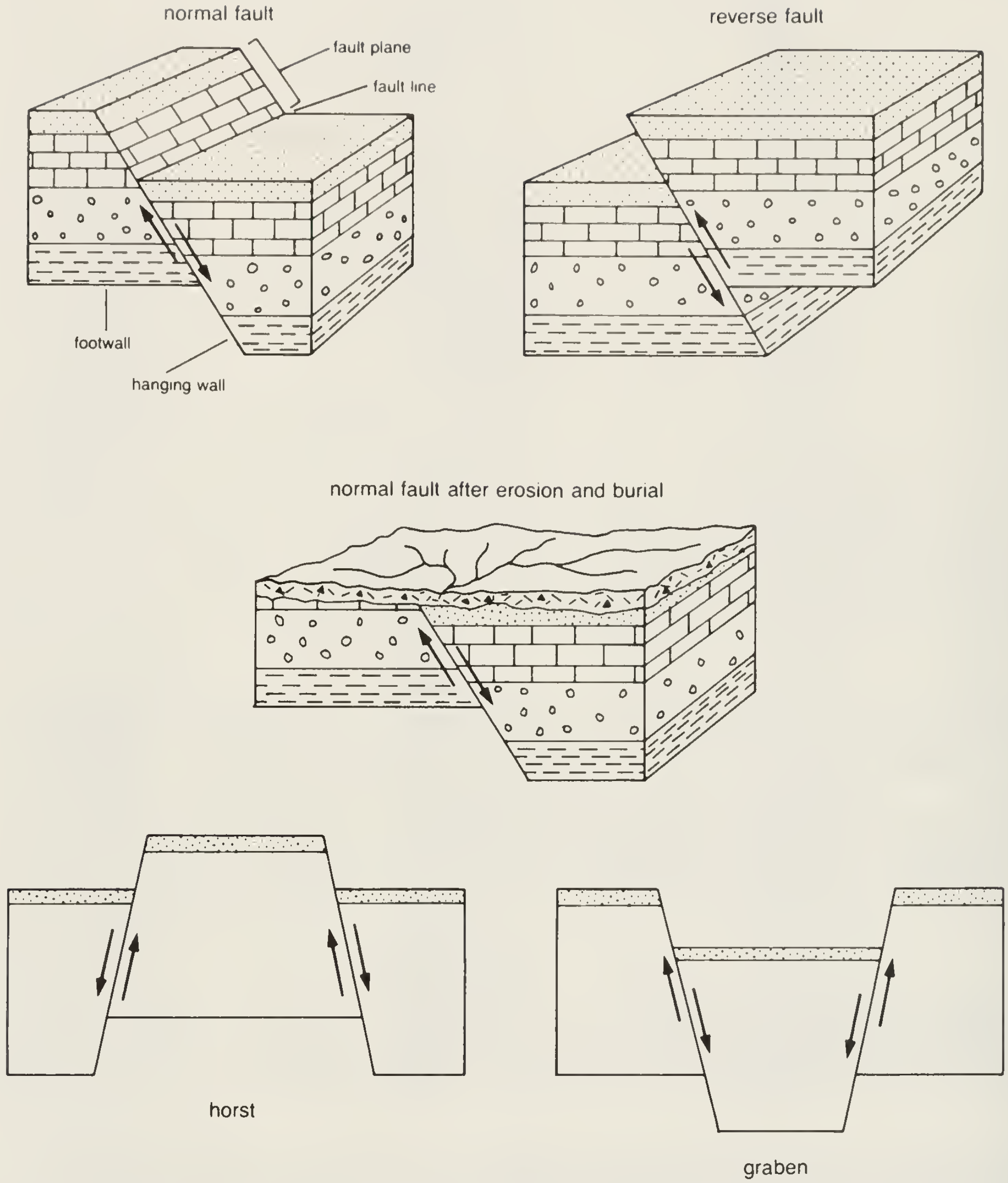


Figure 3 Fault types that may be present in the field trip area (arrows indicate relative directions of movement of each side of the fault).

arch. The La Salle Anticlinal Belt is a complex structure with smaller structures such as domes, anticlines, and synclines superimposed on the broad upwarp of the belt. This gradual arching continued through Pennsylvanian time. Because the youngest Pennsylvanian strata are absent from the area of the anticlinal belt (either because they were not deposited or because they were eroded), we do not know just when movement along the belt ceased.

During the Mesozoic Era following the Paleozoic Era, the rise of the Pascola Arch (fig. 1) in southeastern Missouri and western Tennessee formed the Illinois Basin and separated it from other basins to the south. The Illinois Basin is a broad, subsided region covering much of Illinois, southern Indiana, and western Kentucky (figs. 1 and 5). Development of the Pascola Arch, in conjunction with the earlier sinking of deeper parts of the area that later became the

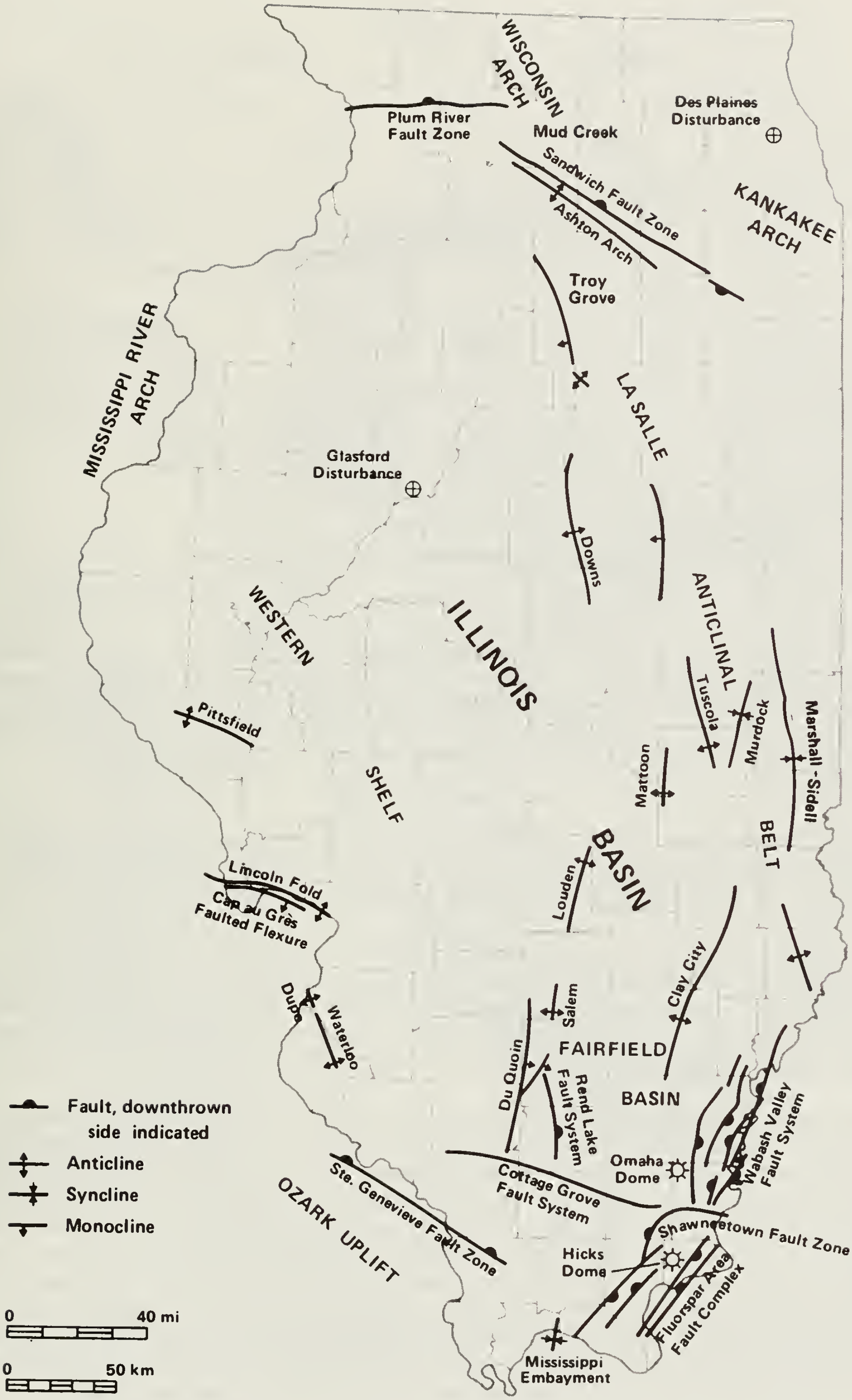


Figure 4 Major geologic structures of Illinois, compiled by J. D. Treworgy (1979).

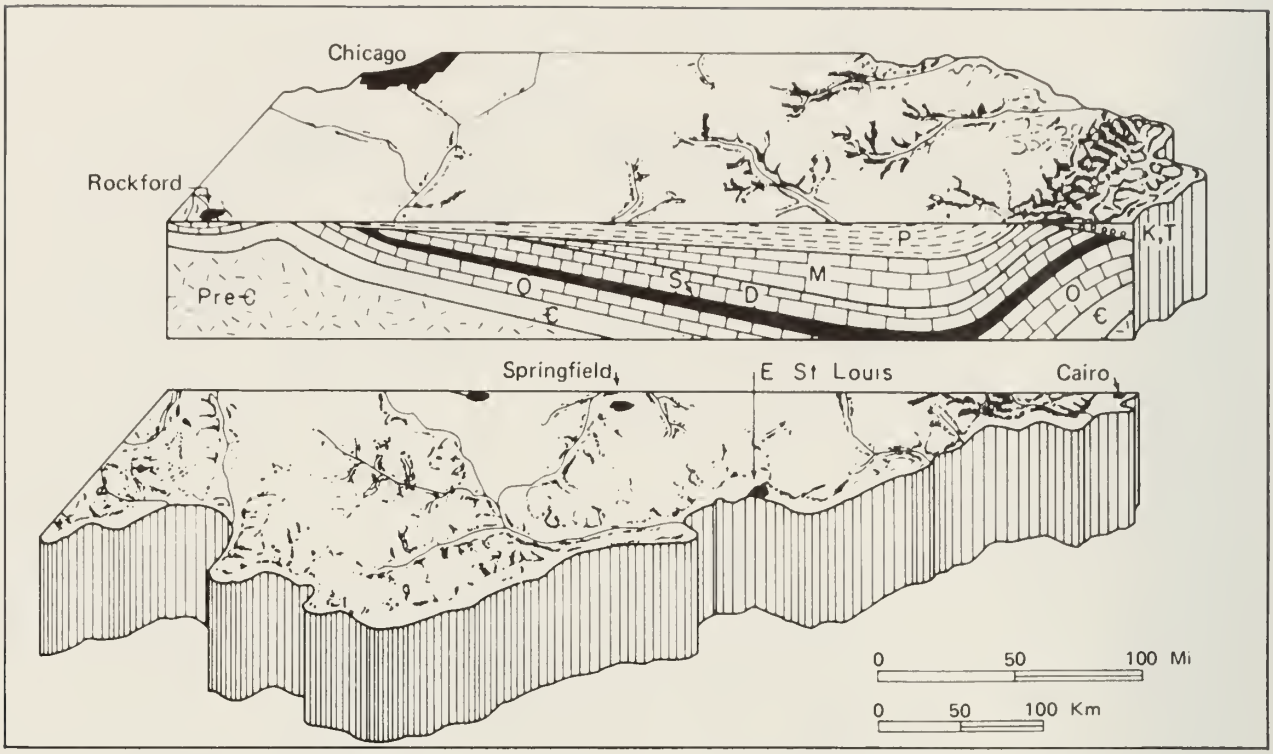


Figure 5 Stylized north-south cross section shows the structure of the Illinois Basin. The thickness of the sedimentary rocks has been greatly exaggerated to show detail, and the younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-C) granites. They form a depression filled with layers of sedimentary rocks of various ages: Cambrian (C), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). Scale is approximate.

Illinois Basin, gave the basin its present asymmetrical, spoon-shaped configuration. The geologic map (fig. 6) shows the distribution of the rock systems of the various geologic time periods as they would appear if all the glacial, windblown, and surface materials were removed.

The Nashville field trip area is in the southwestern part of the Illinois Basin, where smaller subsidiary structures were superimposed on the larger basin structure at different times during the geologic past. Washington County lies just west of the Du Quoin Monocline, the western boundary of the Fairfield Basin. Because the bedrock layers were tilted several times during the Paleozoic Era, the dips of successive strata are not parallel to one another.

Evidence from outcrops and drill holes elsewhere in Illinois suggests that younger rocks of latest Pennsylvanian and perhaps Permian age (the youngest rock systems of Paleozoic age) may have at one time covered the Washington County area. It is possible that even younger rocks of Mesozoic and Cenozoic ages could also have been present here. Indirect evidence based on the stage of development (rank) of coal deposits and the generation and maturation of petroleum from source rocks (Damberger, 1971) indicates that perhaps as much as 1 1/2 miles of latest Pennsylvanian and younger rocks once covered southern Illinois. However, during the 243 million years or so between the close of the Paleozoic Era and the onslaught of glaciation 1 to 2 million years ago, perhaps several thousands of feet of strata were eroded. In the area that is now Illinois, all rocks except those of Precambrian-age were eroded, and all traces of any post-Pennsylvanian bedrock that may have been present were erased.

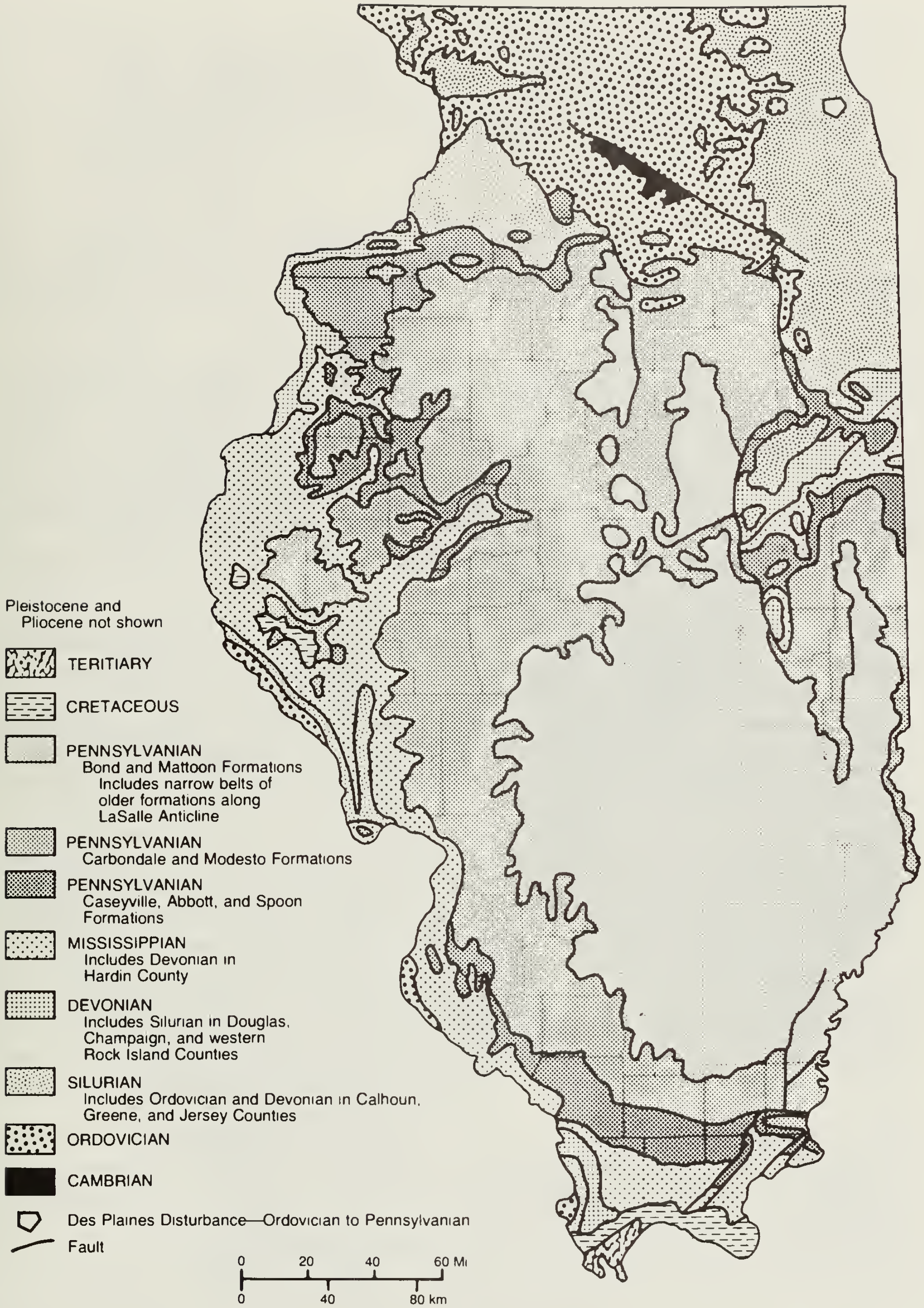


Figure 6 Geologic map of Illinois showing lateral distribution of rock systems at the bedrock surface.

Figure 7 Generalized map of glacial deposits in Illinois (modified from Willman and Frye).

During this extended period of erosion, a series of deep valleys was carved into the gently tilted bedrock formations. Later, the topographic relief was subdued by the repeated advance and melting back of continental glaciers that later scoured and scraped the old erosion surface. The erosion and deposition affected all the formations exposed at the bedrock surface in Illinois. The final melting away of the glaciers left behind the nonlithified deposits in which our Modern Soil has developed.

Glacial History

A brief general history of glaciation in North America and a description of the deposits commonly left by glaciers (*Pleistocene Glaciations in Illinois)* is included in the appendix of this guidebook.

During the Pleistocene Epoch, which began about 1.6 million years ago, massive sheets of ice thousands of feet thick (continental glaciers) flowed slowly southward from centers of snow and ice accumulation in Canada. The last of these glaciers melted from northeastern Illinois about 13,500 years before the present (B.P.). Although ice sheets covered parts of Illinois several times during the Pleistocene Epoch, no deposits of drift from the oldest (pre-Illinoian) glaciers have been found this far south. During the Illinoian glacial stage, which began around 500,000 years B.P., North American continental glaciers advanced to their southernmost position—as far south as the northern part of Johnson County, about 58 miles southeast of Nashville (fig. 7).

The topography of the bedrock surface throughout much of Illinois is largely hidden from view by glacial deposits except along the major streams, and in many areas the glacial drift is thick enough to completely mask the underlying bedrock surface. But in the field trip area, studies of mine shafts, water-well logs and other drill-hole information, along with observations of scattered bedrock exposures in stream valleys and road cuts, indicate that the present land surface is largely a reflection of the configuration of the underlying bedrock surface. The thin mantle of glacial drift here modified the preglacial bedrock surface only slightly.

Until recently, glaciologists assumed that these glaciers may have been a mile or more thick. However, the maximum thickness of the ice may have been only about 2,000 feet in the Lake Michigan Basin and about 700 feet across most of the land surface. That conclusion is based on several lines of research evidence: (1) the degree of consolidation and compaction of rock and soil materials that must have been under the ice; (2) comparisons between the inferred geometry and configuration of the ancient ice masses and those of present-day glaciers and ice caps; (3) comparisons between the mechanics of ice-flow in modern-day glaciers and ice caps and those inferred from detailed studies of the ancient glacial deposits, and (4) the amount of rebound of the Lake Michigan Basin as the heavy mass of glacial ice (that had depressed the land beneath it) melted and relieved the pressure.

Although Illinoian glaciers probably built morainic ridges (landforms consisting of debris carried and then deposited by glaciers) similar to those of the later Wisconsinan glaciers, the Illinoian ridges apparently were not nearly so numerous or prominent, and those that formed were exposed to weathering and erosion thousands of years longer than their younger Wisconsinan counterparts. Nashville is about 70 miles southwest of the Shelbyville Moraine, the oldest moraine deposited during the Wisconsinan glacial stage. Radiocarbon dates suggest that this moraine was deposited about 22,000 years before present (B.P.).

A cover of windblown silt, Peoria Loess (pronounced "luss"), mantles the glacial drift (earth materials carried and deposited by glaciers) in Washington County to depths ranging from about 4 feet in the southeast to about 7 feet in the northwest on the southeast side of the Kaskaskia River. These fine-grained dust deposits of Wisconsinan age, are more than 15 feet

Figure 8 Physiographic divisions of Illinois.

thick near the Mississippi and Illinois Rivers. Soils in the Washington County area have developed in the loess and the weathered, silty, clayey, Illinoian till that lies beneath it.

Physiography

The Nashville field trip area is in the western part of the Mt. Vernon Hill Country just south of the boundary with the Springfield Plain. The Mt. Vernon Hill Country and the Springfield Plain are both divisions of the Till Plains Section of the Central Lowland Physiographic Province (fig. 8). The Mt. Vernon Hill Country has a mature (mostly sloping) topography of low relief with a few upland prairie remnants and alluviated (sediment-filled) valleys along the larger streams.

Because of the thinness of drift in this area, glacier-built landforms are either lacking or difficult to recognize. The local features here were determined primarily by the preglacial topography.

Prior to glaciation, an extensive lowland called the "central Illinois peneplain" was eroded into the relatively weak rocks of Pennsylvanian age east and south of the present-day Illinois River (Horberg 1946, Leighton, Ekblaw, and Horberg 1948). The surface, generally of low relief, slopes slightly from elevations of more than 500 feet in the northeastern part of Washington County to elevations of less than 500 feet in the southwestern part. By the time glaciation began about 1.6 million years ago, an extensive system of bedrock valleys was deeply entrenched below the level of the central lowland surface. In Washington County, preglacial streams had eroded their channels to bedrock elevations of approximately 400 feet (msl) in the southern part and to around 300 feet (msl) in the northwestern part.

As glaciation began, less water probably flowed in the streams, and they stopped eroding their channels. Although there were huge volumes of water in the meltwater streams gushing from the ice front, they were so laden with glacial debris that they could not transport the debris very far. Stream channels quickly became choked with outwash materials. The early glacial deposits in the stream valleys apparently were never completely flushed out of the stream channels by succeeding torrents of meltwater during later deglaciations.

Drainage

In the Nashville area, a drainage divide in the network of buried preglacial valleys is located about 5 miles south of the northeast corner of the county. This divide extends roughly southwestward to about 7 miles east of the southwestern corner of the county. Drainage northwest of the divide was through the Ancient Kaskaskia River to the Ancient Mississippi River. Drainage southeast of the divide flowed generally southward into the Ancient Big Muddy River to the buried Lower Mississippi River. Glacial drift is unevenly distributed across Washington County, partly because of the irregular bedrock surface and partly because of erosion. In the partly buried valley of the Kaskaskia River, glacial drift is a little more than 100 feet thick, but the uplands generally have less than 25 feet of till.

Most streams in the present-day drainage system of the Nashville area have low gradients (bottom slopes) and are actively widening their bottomlands. The uplands generally have good natural drainage. Nashville Creek and its tributaries flow northward to the Kaskaskia River, draining the immediate Nashville vicinity. By the time we get to Stop 1 in this field trip, we will have crossed the drainage divide between the Kaskaskia River on the north and the Big Muddy River on the south. Both of these rivers empty into the Mississippi River southwest of here. The area to the south is drained by Beaucoup and Locust Creeks and Little Muddy River (and their tributaries). These sluggish streams generally occupy the alluviated preglacial bedrock valleys.

Relief

The highest land surface along the field trip route—a surface elevation of slightly more than 560 feet above mean sea level (msl)—is near Stop 1. The lowest elevation, slightly less than 460 feet msl, is on Beaucoup Creek in the vicinity of Stop 6. The highest surface elevation in the field trip area (593 feet msl) occurs along US Route 51, 2.8 miles northwest of Stop 9. Therefore, the surface relief of the field trip area, calculated as the difference between the highest and lowest surface elevations, is more than 130 feet. Local relief of 30 to 40 feet is most pronounced on the south side of Nashville at Stop 1.

MINERAL RESOURCES

Groundwater

Groundwater is a renewable mineral resource often overlooked in assessments of an area's natural resource potential. The availability of water is essential for economic and community development. About 52 percent of the state's 11 million citizens depend on surface water resources, such as lakes and rivers; the rest rely on groundwater supplies. Groundwater occurs in pores, open joints, fractures, and solution channels in rocks; it becomes increasingly mineralized with depth. Groundwater is derived from underground formations called aquifers. (An aquifer is a body of rock that contains enough water-bearing porous and permeable materials to release usable quantities of water into an open well or spring.) The water-yielding capacity of an aquifer can only be evaluated by constructing test wells into it. The wells are pumped to determine the quality and quantity of groundwater available for use.

Because glacial deposits are thin throughout Washington County, deposits of water-yielding sand and gravel are also thin, occurring mainly in the deeper parts of the larger streams. Most of the reliable wells for residential, light industrial, and farm use in the field trip area tap water-yielding sandstones in the upper part of the Pennsylvanian System at depths ranging from 150 to 350 feet.

Surface water

Nearly all the larger municipalities in Washington County have interconnecting community water systems that rely on surface water. Nashville receives about 315,900 gallons per day (gpd) of treated surface water from the Nashville Reservoir and about 339,300 gpd from the Washington County State Conservation Area lake; some 50,000 gpd from these sources goes to two smaller communities to the north. The Washington County Water Company, whose water supply reservoir is a prominent landmark about a mile south of Nashville along SR 127, distributes nearly 343,000 gpd of treated water from the Kaskaskia River to the west in St. Clair County. Of this amount, Radom receives 12,000 gpd and Du Bois 24,900 gpd.

Mineral Production

Of the 102 counties in Illinois, 99 reported mineral production during 1988, the last year for which complete records are available. (The term "complete" may be somewhat of a misnomer, since stone production is reported for the odd-numbered years and sand and gravel production is reported for the even-numbered years). The total value of all minerals extracted, processed, and manufactured in Illinois was $2.8 billion (Samson and Bhagwat, in press). Coal continued to be the leading commodity in 1988, followed by oil, stone, sand and gravel, and clays. Illinois is 17th among the 50 states in total production of nonfuel minerals and continues to lead all other states in production of fluorspar, industrial sand, and tripoli.

In 1988, Washington County produced coal, crude oil, and stone valued at more than $51.7 million. This value ranks it 15th among all Illinois counties. One underground slope mine produces from the Herrin (No. 6) Coal Member of the Pennsylvanian Carbondale Formation in the southwestern part of the county. The mine is equipped with continuous mechanical miners, which recover coal averaging about 6.7 feet thick; it produced 1,621,900 tons of coal in 1988, valued at more than $46.3 million. Since operations were begun in 1979, the mine has produced a total of 11,062,251 tons of coal. Cumulative coal production for Washington County reported from 1833 through 1988 amounted to more than 29.2 million tons, all from underground mines.

Oil and gas production in Washington County accounted for 1.5 percent of the state's total for 1988 (fig. 9). Oil production amounted to 340,000 barrels of oil valued at $5,032,000. Cumulative oil production reported from 1888 through 1988 amounted to 35,490,000 barrels.

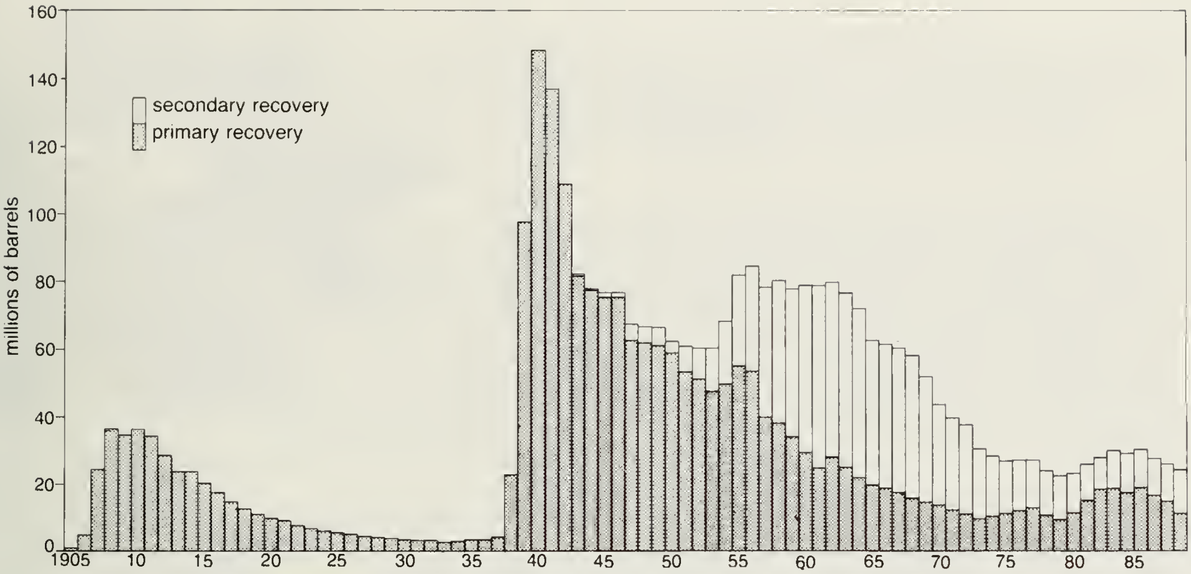
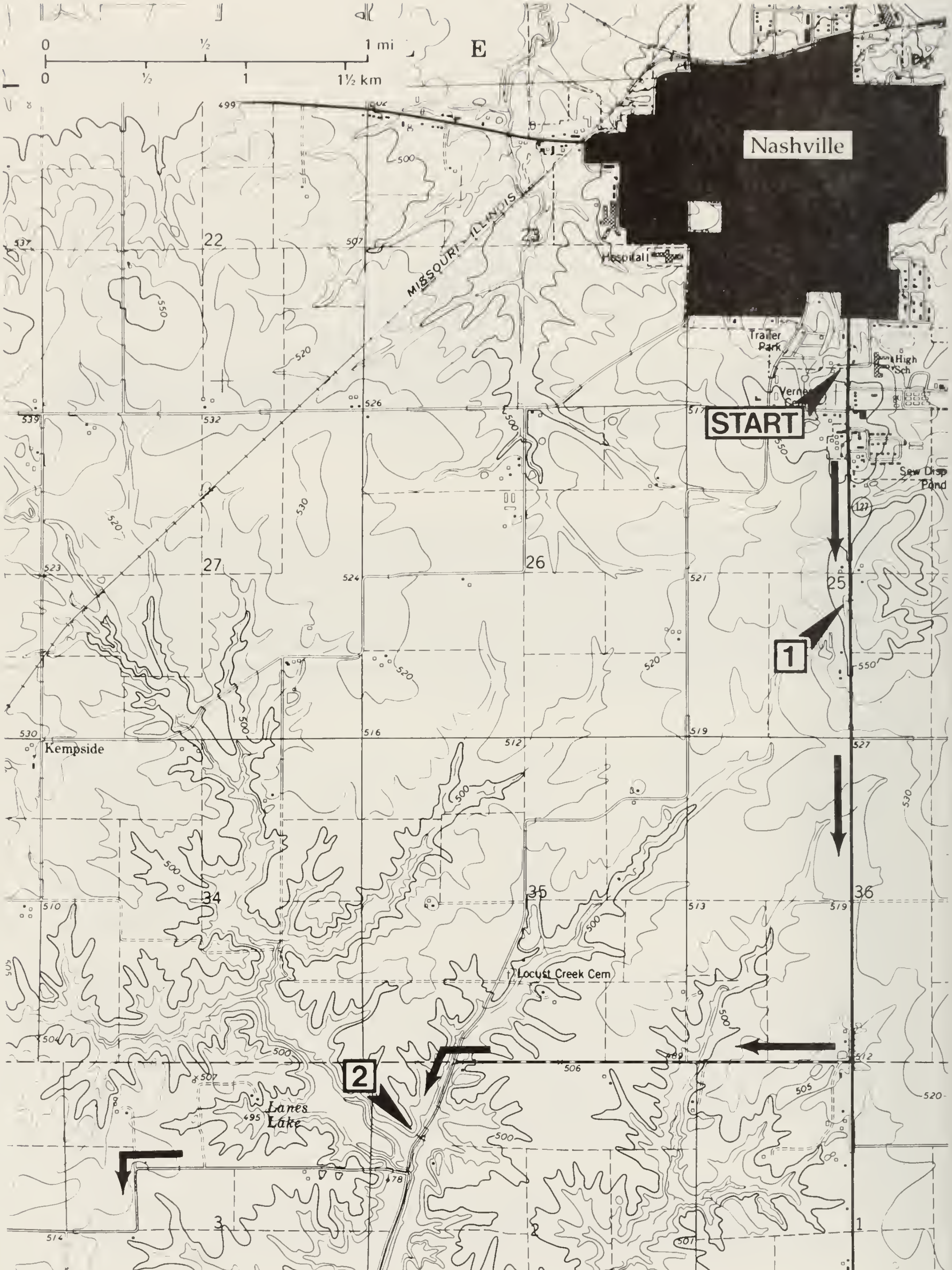


Figure 9 Annual crude oil production in Illinois, 1905-1988.

Total Illinois stone production was estimated at 57.9 million tons in 1988. Stone is used primarily for construction aggregate, especially as road-base material; it is also used for chemical, agricultural, and other purposes. Illinois' tonnage ranked seventh among 49 states reporting production of crushed and broken stone. Washington County is in the U.S. Bureau of Mines District 4 in southern Illinois. Fifteen counties, including Washington, in this region reported stone production for 1988 from 30 companies and 33 operations. More than 9.5 million tons of stone, having a value greater than $33 million, were produced.



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GUIDE TO THE ROUTE

Line up west of Nashville High School on East Student Drive. Mileage calculations will begin at the T-intersection of East Student Drive and South Mill Street (State Route 127) (SE NE SE SW Sec. 24, T2S, R3W, 3rd P.M., Washington County; Nashville 7.5-minute Quadrangle [38089C4*]).

NOTE: A little more than 1 mile north of here and about 0.15 mile east of State Route (SR) 127 is the site of the Nicholson Coal Mining Company shaft. This mine in the Herrin (No. 6) Coal Member of the Pennsylvanian Carbondale Formation reached the coal, which averaged slightly less than 6 feet thick at a depth of 425 feet. The mine was located on the north side of the Louisville and Nashville Railroad Company (now CSX Transportation Company) tracks (1,600 feet from the north line and 960 feet from the west line SE *or* NW NE SW SE Sec. 13, T2S, R3W, 3rd P.M., Washington County; Nashville 7.5-minute Quadrangle [38089C4]). This is close to the site of the sewage treatment plant.

In 1917, the mine became the Nashville Mining Company. From 1923 to 1939, when it was abandoned, it was the Clarkson Coal Mining Company. Numerous faults with displacements of 2 to 3 feet were reported in the mine. No tonnage figures are readily available.

Miles to next point	Miles from start	
0.0	0.0	STOP (1-way). TURN LEFT (south); USE CAUTION entering the highway.
0.6	0.6	Prepare to park just ahead.
0.1+	0.7+	PARK on paved road shoulder. Please do NOT block driveway. CAUTION: fast traffic. Stay off the highway.

STOP 1 We'll look over part of the Illinoian till plain from the high glacial-till-capped bedrock hill south of Nashville (west side of SR 127; near center, east line NE NE SW Sec. 25, T2S, R3W, 3rd P.M., Washington County, Nashville 7.5-minute Quadrangle [38089C4]).

This hill affords a good view of the Illinoian till plain to the south and west. Although the hill, which is more than 560 feet above mean sea level (msl), stands only 30 to 40 feet above the till plain, it seems much higher. There are no large, close stands of timber or large buildings to obstruct the view.

The Hagarstown Member of the Illinoian Glasford Formation (Lineback et al. 1979), the most widespread glacial formation in Illinois, caps this hill. In this region the Hagarstown overlies the Illinoian Vandalia Till Member of the Glasford Formation. The Hagarstown generally consists of well-sorted and well-bedded sand and gravel that may be locally cemented. In some areas it

* The number in brackets [38089C4] after the topographic map name is the code assigned to that map as part of the National Mapping Program. The state is divided into 1° blocks of latitude and longitude. The first two numbers refer to the latitude of the southeast corner of the block; the next three numbers designate the longitude. The blocks are divided into 64 7.5-minute quadrangles; the letter refers to the east-west row from the bottom, and the last digit refers to the north-south column from the right.

consists of till that may be sandy, probably due in part to the intermixing with underlying weathered sandstone bedrock. This member occurs in kames and crevasse fillings. Wilson, Odom, and Hanagan (1958) described the hill as a morainic ridge, a remnant of a moraine deposited by the Illinoian Monican glacier.

As noted in the introduction, Illinoian glaciers probably deposited moraines similar to those left by Wisconsinan glaciers; but because the deposits are not indurated or lithified, they are more easily eroded than bedrock. There also appear to have been fewer Illinoian moraines, which were subjected to weathering and erosion for well over 200,000 years longer than their Wisconsinan counterparts.

On the east side of SR 127, about 0.3+ mile ahead (south), is an exposure of Pennsylvanian sandstone in the ditch. Downcutting by runoff water in the ditch has reached to the top of the bedrock surface, which is much harder than the overlying sandy till. Thus, downcutting has been impeded and the runoff stream has been cutting laterally at its banks and seeking a shorter, faster way through the bedrock, such as a less resistant area or an open joint or fracture. The result is that the weak glacial debris is being undercut, causing it to slump into the ditch. If you are alert, you may see other examples of this type of erosion on the trip.

To the south and west the land falls gently away from this elevation. The topography is consistent with the form of Wisconsinan moraines to the north. From here the till plain looks flat, but as we proceed along the route, you will see that the surface is gently rolling and dissected considerably by the headward extension of drainage.

0.0	0.7+	Leave Stop 1. CONTINUE AHEAD (south). Use CAUTION when pulling back onto the highway.
0.3+	1.05	In the ditch to the east, Pennsylvanian sandstone is exposed under slumped Quaternary deposits. CONTINUE AHEAD (south).
1.0	2.05	Prepare to turn right just ahead.
0.1	2.15	TURN RIGHT (west) at narrow T-road intersection.
1.2+	3.35+	CAUTION: unguarded T-road intersection. Visibility is limited. TURN LEFT (south).
0.15	3.5+	Prepare to park ahead.
0.1	3.6+	PARK along the road shoulder as far off the roadway as you can safely. CAUTION: limited visibility.

STOP 2 We will examine a soil profile in Quaternary-age deposits exposed in the southeast-facing roadcut (near center, west line SE NW NW Sec. 2, T3S, R3W, 3rd P.M., Washington County; Nashville 7.5-minute Quadrangle [38089C4]). In this exposed section, you will be able to see

1. top soil (Wisconsinan Peoria Loess) that is brown with a reddish cast—noncalcareous, silty clay loam that breaks along curved surfaces (starchy fracture) in the lower 1.5 feet 2 feet

2. silt (Roxana Silt?) that is gray with brown mottling and a faint pinkish cast; it is harder and more blocky than the soil above it when dry, but it becomes very weak when wet. Soil scientists (pedologists) would call it a "fragipan" — 1± foot

3. silt that is olive gray, clayey, blocky, and hard and tough when dry but plastic when wet; it contains scattered small pebbles that become more abundant and larger downward (chert fragments up to 3 inches long and quartz pebbles up to 1/2 inch in diameter). The gray zone is the gleyed part of a B horizon of a weathering profile that has been called an accretion-gley soil or paleosol — 12± feet

4. silt that is mottled gray and yellow-brown with a slight reddish cast; the C soil horizon is weathered, sandy with small pebbles 1/2 to 3/4 inch in diameter, and hard when dry — 1.5 feet

5. silt that is yellow-brown and dolomitic; it contains scattered pebbles up to 3/8 inch in diameter and traces of mica — 0.5± foot

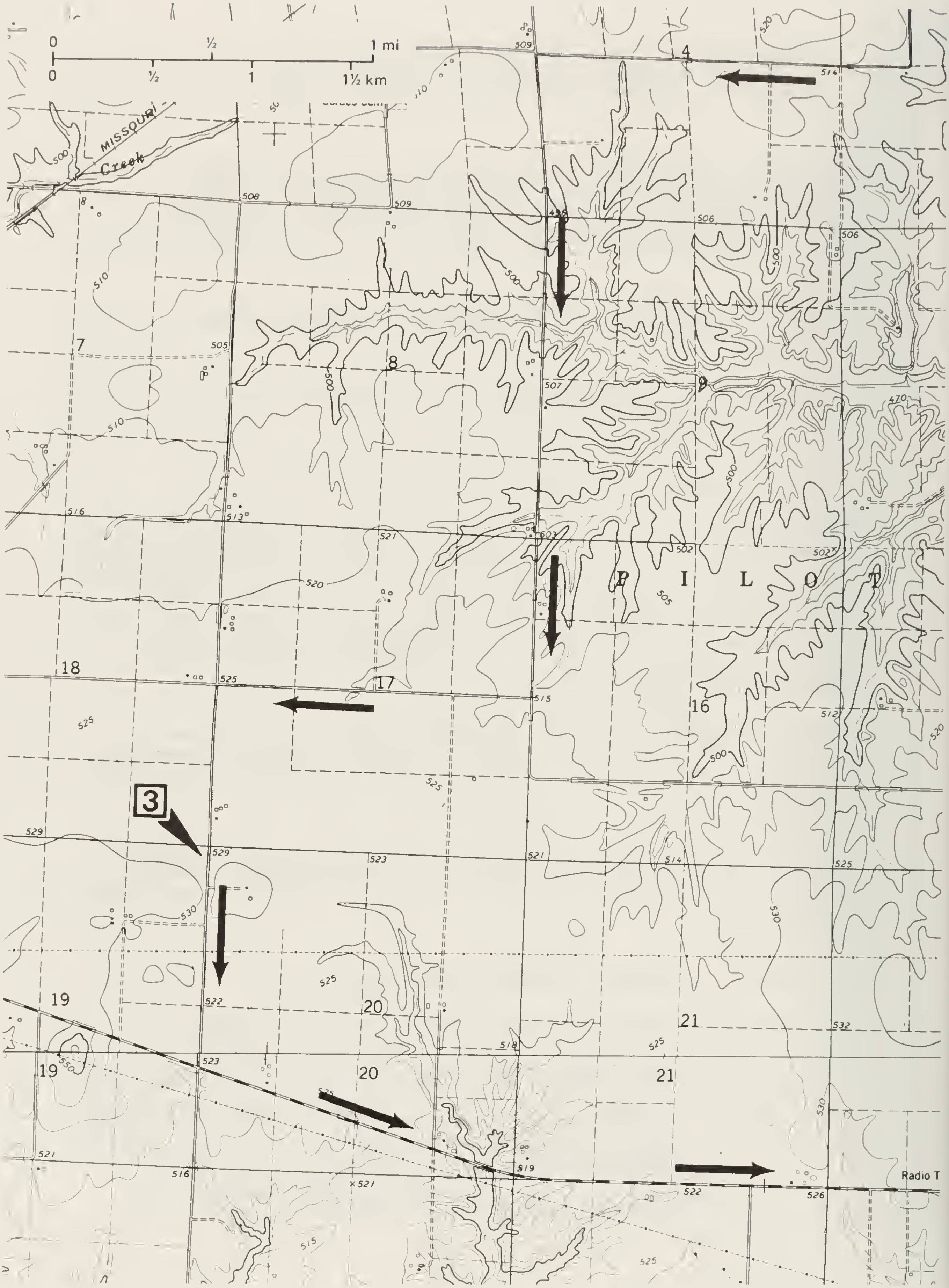
6. claystone that is mottled yellow-brown and gray; it becomes harder and more coherent downward; it is micaceous and contains manganese blebs — 3+ feet

At first glance this exposure seems to be Illinoian till overlain by Wisconsinan loess. Closer examination shows that the middle part of the exposure (units 3 and 4) is material derived from till and deeply weathered by formation of the Modern Soil, so that it has the appearance of one weathering profile in the exposure. Units 3 and 4 were initially weathered by the formation of the Sangamon Soil before they were buried by the Roxana Silt (unit 2) and Peoria Loess (unit 1)—both produced by wind action during the Wisconsinan Stage. The clayey and blocky character is typical of the Sangamon Soil in exposures and quite similar to Sangamon profiles in glacial till at other locations in the region.

The lower part of Unit 4 is sandy, which indicates that the material is probably reworked till—that is, streams and surface water in the area reworked the original glacial deposits. Units 5 and 6 are highly weathered Pennsylvanian silty shales, as the large amounts of muscovite mica (isinglass) show.

This type of exposure is fairly common across the Illinoian till plain where the drift is draped thinly across the bedrock surface. The best chances of finding good glacial till under these circumstances is to locate preglacial valleys cut into the bedrock surface, where the till deposits are more protected.

0.0	3.6+	Leave Stop 2. CONTINUE AHEAD (south).
0.1+	3.75+	Cross bridge and TURN RIGHT (west) at T-road intersection.
0.85	4.6+	Note the gently undulating surface of the Illinoian till plain in this area.
1.35+	5.95+	CAUTION: unguarded offset cross road. TURN LEFT (south). NOTE: on your large-scale route map in the guide leaflet, look at the slanted section and quarter-section lines on this tier of sections.
2.0	7.95+	TURN RIGHT (west) at T-road intersection.



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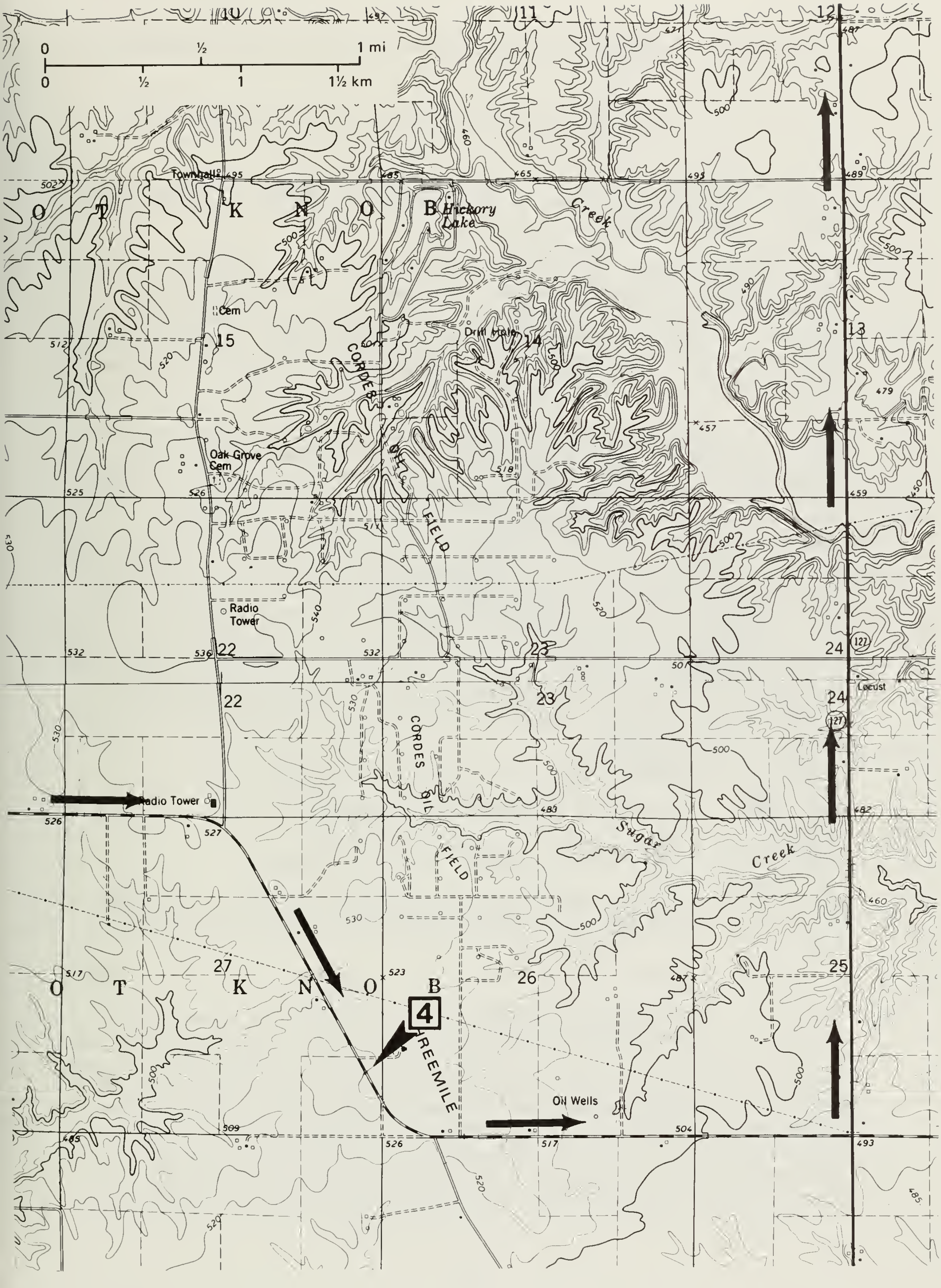

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11
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Townhall
O T K N O B
Hickory Lake
Creek
Cem
15
Drill Hole
14
13
CORDES OIL FIELD
Oak Grove Cem
Radio Tower
22
23
24
127
Locust
CORDES OIL FIELD
Radio Tower
Sugar Creek
27
26
25
O T K N O B
4
TREEMILE
Oil Wells

0.95+	8.95+	CAUTION: unguarded crossroad. TURN LEFT (south) and prepare to park in 0.5 mile.
0.5+	9.5	PARK along road shoulder as far off the roadway as you can safely.

STOP 3 We will discuss the Illinoian till plain along the roadside about 7 miles southwest and in view of Nashville (near northeast corner, Sec. 19, T3S, R3W, 3rd P.M., Washington County; Nashville 7.5-minute Quadrangle [38089C4]).

No end moraine is readily recognizable, and the ground moraine is generally quite thin, except where it fills in some bedrock valleys; thus it would appear that the Illinoian Monican glacier, which reached the farthest south of the Quaternary continental glaciers, did not cover this region long. Also, the southern glacial boundary is generally quite difficult to recognize because most glacial erratics have been pulverized or weathered away, and the drift is very thin and highly weathered.

When the Pleistocene climate changed somewhat, the accumulation of snow and ice greatly diminished in Canada and the outward spread of the ice margin stopped. The ice sheet became stagnant. As the climate continued to moderate, the ice front melted and the surface cracked. Meltwater coursed across the ice surface and into the cracks, enlarging them. Some of the rock and soil debris carried within the ice melted out and was flushed into these crevasses. At least some of the elongate ridges noted on the Illinoian till plain appear to be the result of crevasse filling. Other debris was dumped off the edge of the huge ice blocks and formed fan-shaped deltas leaning against the ice. When the ice melted, the deltas collapsed into low, roughly circular hills called "kames," which may be composed largely of sand and gravel. The low hills in this vicinity, upon which the farmhouses are situated, appear to be small kames. Much of the remaining glacial debris was just lowered to the ground and spread across the surface blanketing the bedrock surface when the ice melted. Glacial drift in this part of Washington County ranges from a few inches to more than 100 feet in the Kaskaskia River valley. Across the uplands, the drift hardly covers bedrock in some places, but may be more than 50 feet thick in other places.

0.0	9.5	Leave Stop 3. CONTINUE AHEAD (south).
0.65+	10.15+	STOP: 2-way at cross road. TURN LEFT (southeast).
2.45	12.6+	To the left, as you enter the right curve is a large telephone microwave transmission tower. CONTINUE AHEAD (southeast).
0.9	13.5+	Prepare to park ahead.
0.1	13.6+	PARK along the roadside as far off the pavement as you can safely. CAUTION: fast traffic. Stay off the pavement.

STOP 4 At this vantage point along the "Three Mile Prairie" in the Cordes Oil Field (southwest roadside SW NE NE SE SE Sec. 27, T3S, R3W. 3rd P.M., Washington County; Winkle 7.5-Minute Quadrangle [38089B4]), we will discuss the occurrence and production of oil in Washington County.

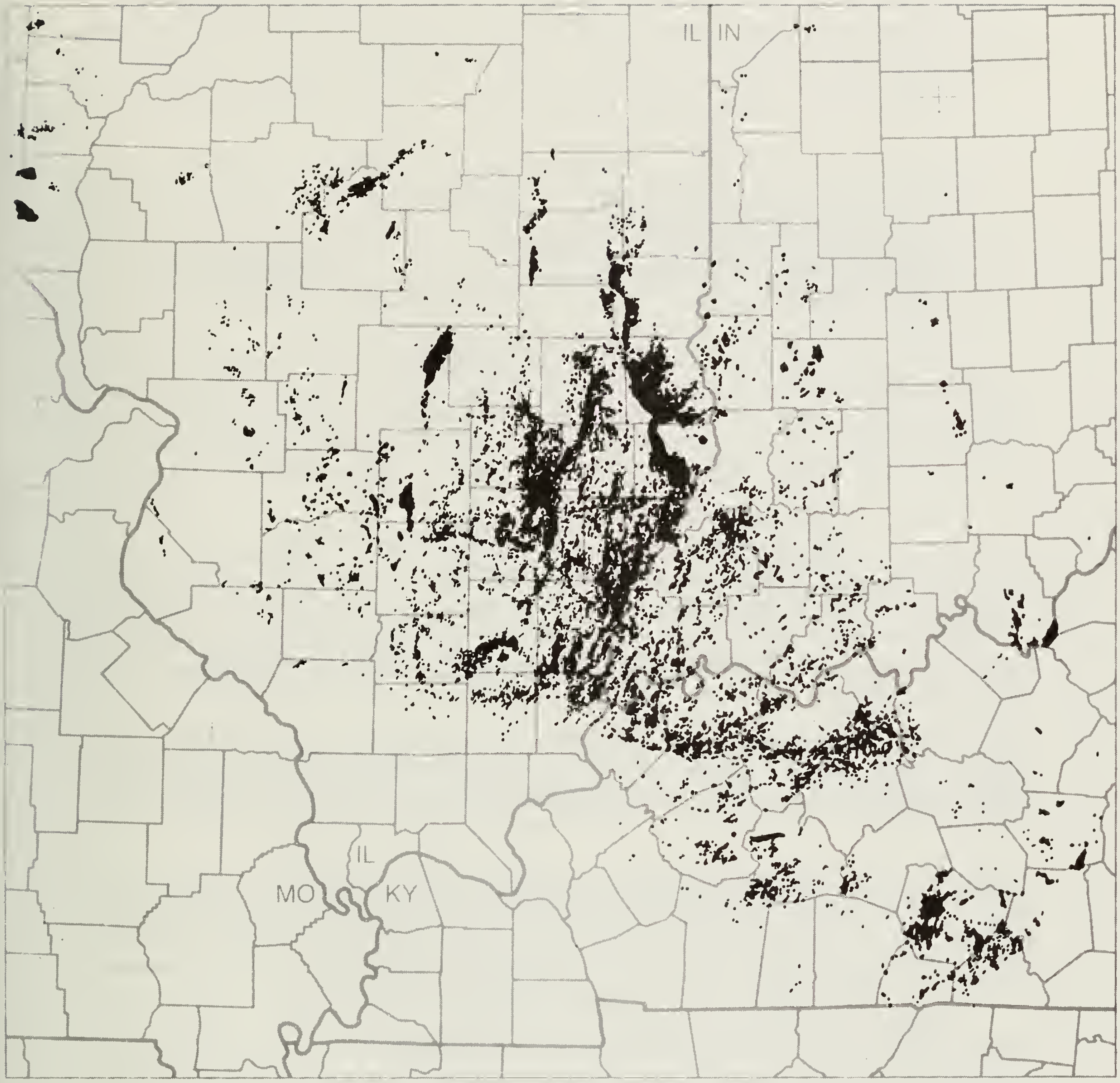


Figure 10 Oil fields of the Illinois Basin.

Surrounding this location are several oil fields that produce from various formations. Each field lies over an area where oil is trapped in porous rocks. Figure 10 is a small-scale map of the Illinois Basin oil fields. There are several kinds of oil traps (fig. 11) and they are rarely easy to locate. Geologists use many techniques to predict the kind of trap, how to look for it, and where to find it.

Cordes Oil Field The rocks immediately beneath the surficial deposits at this stop are Pennsylvanian in age, which means they were deposited about 290 million years ago. If we could see these rocks, we would notice that they are arched or folded into an anticline that

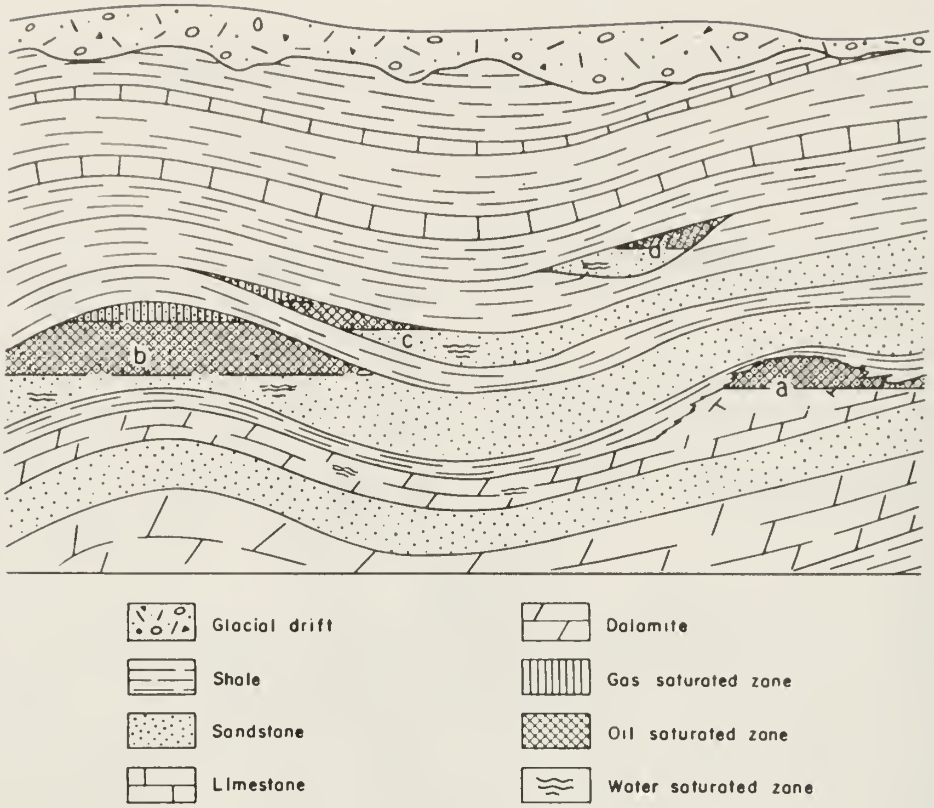


Figure 11 Places where oil is found in Illinois: (a) coral reefs, (b) anticlines, (c) pinchouts, and (d) channel sandstones.

trends northwest-southeast. It is common for oil to become trapped in porous rocks along the crest of such structures, and it is for this reason that the Blankenship No. 1 Dennis well was drilled in Section 14 during 1939. The oil encountered in this well led to the development of Cordes Oil Field.

Production was originally all from sandstones in the Mississippian Benoist Formation (fig. 2) at a depth of 1,260 feet. By the end of August 1950, almost 5.2 million barrels of oil had been produced from 144 wells using primary recovery methods. At that time, the field was placed under a waterflood program (secondary recovery) to extract some of the oil that had been left behind. Since 1950, another 5.3 million barrels of oil have been recovered.

Recent drilling activity at Cordes has discovered a new oil-bearing zone in Lower Devonian rocks about 2800 feet deep. This play is based on new thinking and geological interpretations.

Nashville Oil Field An example of another type of oil trap in the area is Nashville Field, located about 5 miles west of the town of Nashville. This field was discovered in 1973 when the Perry Fulk No. 1 A. Harre encountered oil at about 2700 feet. Since its discovery, Nashville Field has produced almost 2 million barrels of oil.

The trap at Nashville Field is formed by a pinnacle reef (fig. 11) that formed during the Silurian period approximately 420 million years ago. Reefs, which can be very porous, are commonly surrounded by tight interreef limestone muds. Consequently, oil can slowly migrate into the reef rock but cannot escape. This type of trap is called stratigraphic because no structure is needed to confine the oil. Ironically, the most common way to explore for pinnacle reefs is to look for a structure over the reef that was caused by a process called differential compaction. The enormous weight of the overlying sediments caused compaction of underlying strata. The soft

interreef lime muds compacted dramatically, whereas the reef rock did not compact. The effect of this phenomenon was to exaggerate the relief between the reef and the interreef rocks. Sediments then became draped over the reef itself, forming a pronounced, but local, dome that can be observed in sediments even at the surface. The rock layers below the reef show no structure since they were not affected by this differential compaction.

Beaucoup Oil Field A third type of trap is illustrated by Beaucoup Field, 4 miles northeast of the town of Nashville. This field was discovered in 1951 when a well was drilled where a geologist had predicted a small structure believed to be a pinnacle reef. There was no reef, but there was a structure and production was established in Lower Devonian rocks (3,000 feet deep here and 400 million years old). One well encountered oil in Ordovician rocks (4,100 feet deep and about 440 million years old). Total production has exceeded 400,000 barrels of oil.

At Beaucoup, the trap is a combination structural-stratigraphic one—both structure and stratigraphy play a role in trapping the oil and/or gas. Fortunately, a band of porous dolomite in Lower Devonian rocks is buckled over a structure at Beaucoup. This same structure broke the Ordovician Trenton Formation and enabled oil to seep into cracks there. The small size of the structure and the generally poor reservoir quality of the rocks explain why more oil was not trapped there.

Oil and Water Production Water produced with the oil is removed by using separators—large cylindrical tanks with stacks protruding from the top (fig. 12). Separators work by utilizing the tendency of oil to float on water. The oil and water mixture is pumped into the separator and the oil is skimmed off from the top of the tank. Separators are heated in the winter with gas from the field so the separation can take place faster.

0.0	13.6+	Leave Stop 4. CONTINUE AHEAD (south and then east).
0.45+	14.05+	To the left and ahead are a number of tank batteries and operating pump jacks in the Cordes oil field.
1.1+	15.2+	STOP: 2-way at crossroad intersection with SR 127. TURN LEFT (north) on SR 127. CAUTION: fast traffic.
3.6	18.8+	Prepare to turn right ahead.
0.1+	18.95+	TURN RIGHT (east) at entrance road to Washington County State Conservation Area.
0.55+	19.5+	Entrance to Washington County State Conservation Area. CONTINUE AHEAD (east).
0.6+	20.1+	T-road intersection from right. Picnic areas are located 0.55+ mile ahead and 0.45+ mile to the right (southeast). NOTE: after lunch, calculate your mileage from this intersection (western edge SW SW SW NE Sec. 7, T3S, R2W, 3rd P.M., Washington County; Beaucoup 7.5-minute Quadrangle [38089C3]).

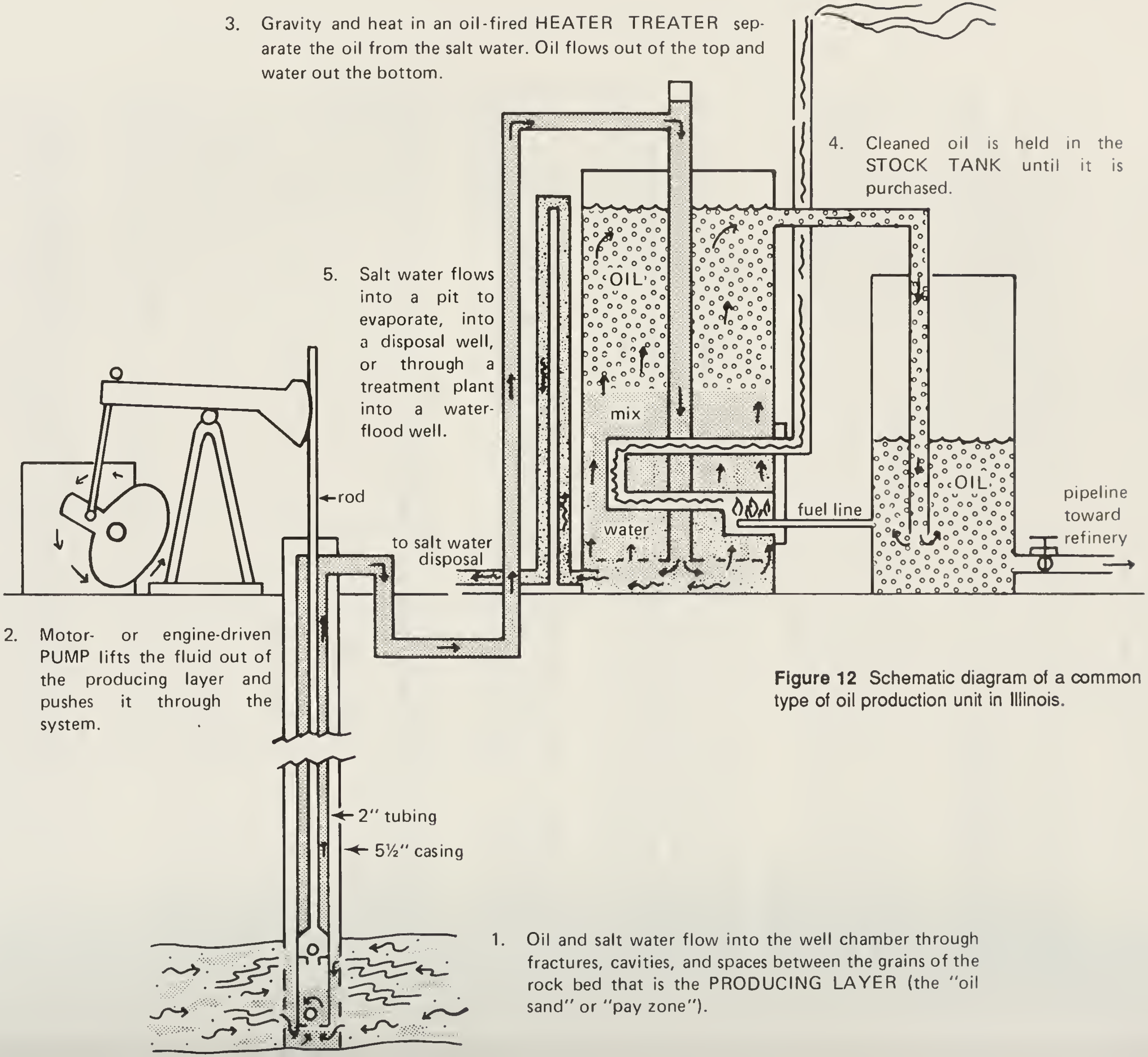
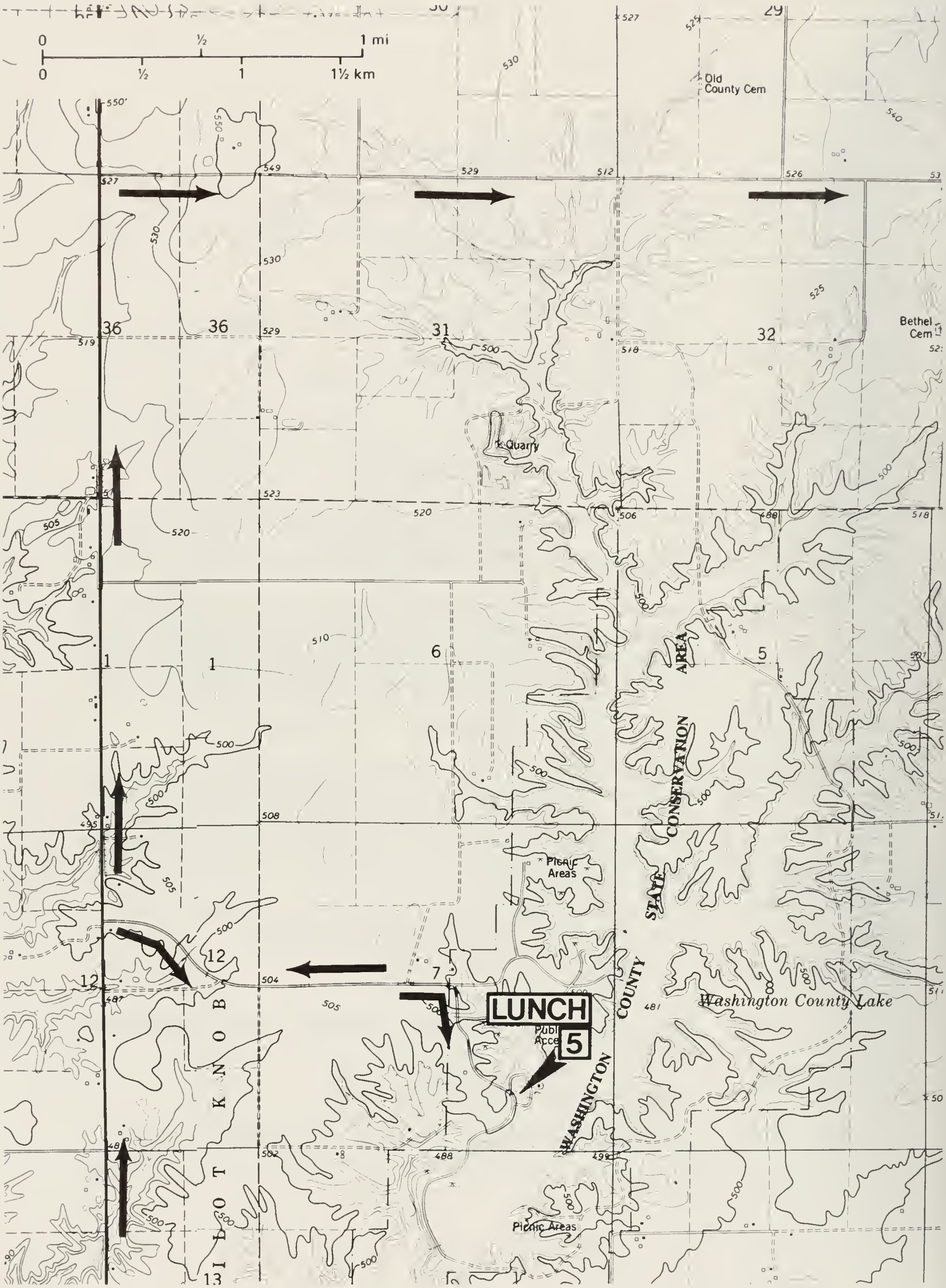


Figure 12 Schematic diagram of a common type of oil production unit in Illinois.

STOP 5 Lunch

0.0	20.1+	Leave Stop 5 and retrace route to SR 127.
0.6+	20.7+	Leave Washington County State Conservation Area.
0.55+	21.3	STOP: 1-way at T-intersection with SR 127. TURN RIGHT (north) on SR 127. CAUTION: fast traffic.
2.2	23.5	Prepare to turn right ahead.
0.1+	23.6+	TURN RIGHT (east) at the T-road from the right. Note the large reservoir tank of the Washington County Water Company.
0.8+	24.4+	CAUTION: unguarded crossroad. CONTINUE AHEAD (east).
0.8+	25.2+	T-road intersection from the right. CONTINUE AHEAD (east).
0.5+	25.75+	T-road intersection from the left. CONTINUE AHEAD (east).
0.25+	26.0+	T-road intersection from the right. CONTINUE AHEAD (east).
0.95+	27.0	Cross Natural Gas Pipeline Company of America transmission lines. There are three pipelines (two 30 inches, and one 36 inches in diameter. This transmission line crosses the Mississippi River via a suspension bridge at Grand Tower as it carries Gulf Coast gas toward Chicago.
0.05-	27.05-	TURN RIGHT at T-road intersection from the south.
0.3	27.3+	Entering Beaucoup Oil Field. The pump jacks are of different sizes. The larger one ahead, at about one o'clock, is pumping from a deeper pay zone than the one at 2:30 o'clock. Between the two pump jacks, you can see the markers for the three pipe lines. At the next road to the south, you see that they lie farther west of our route. CONTINUE AHEAD (south).
1.7	29.0+	Crossroad. This is the back (east) entrance to the Washington County State Conservation Area. CONTINUE AHEAD (south).
1.9	30.9+	Prepare to turn left ahead.
0.1+	31.0+	CAUTION: you are at an unguarded T-road intersection. Cross traffic does NOT stop. TURN LEFT (east).
0.65+	31.7	Cross Beaucoup Creek and prepare to park.
0.05+	31.75+	PARK along road shoulder. DO NOT BLOCK the bridge or driveway.



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Old County Cem
Bethel Cem
Quarry
Picnic Areas
LUNCH
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STATE CONSERVATION AREA
WASHINGTON COUNTY
Washington County Lake
PILOT KNOB
Picnic Areas
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12
12
7
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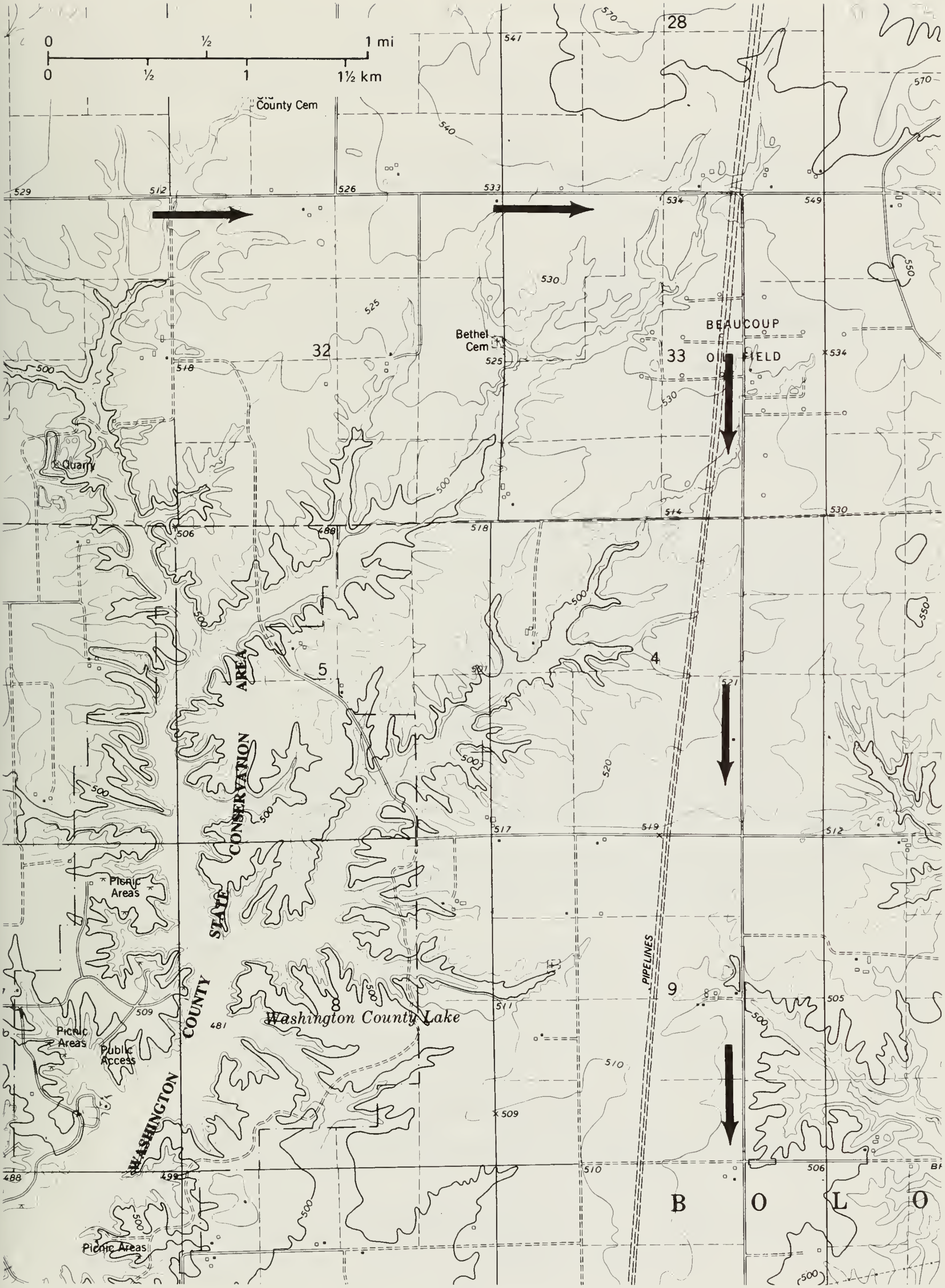

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County Cem
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BEAUCOUP
OIL FIELD
Bethel Cem
Quarry
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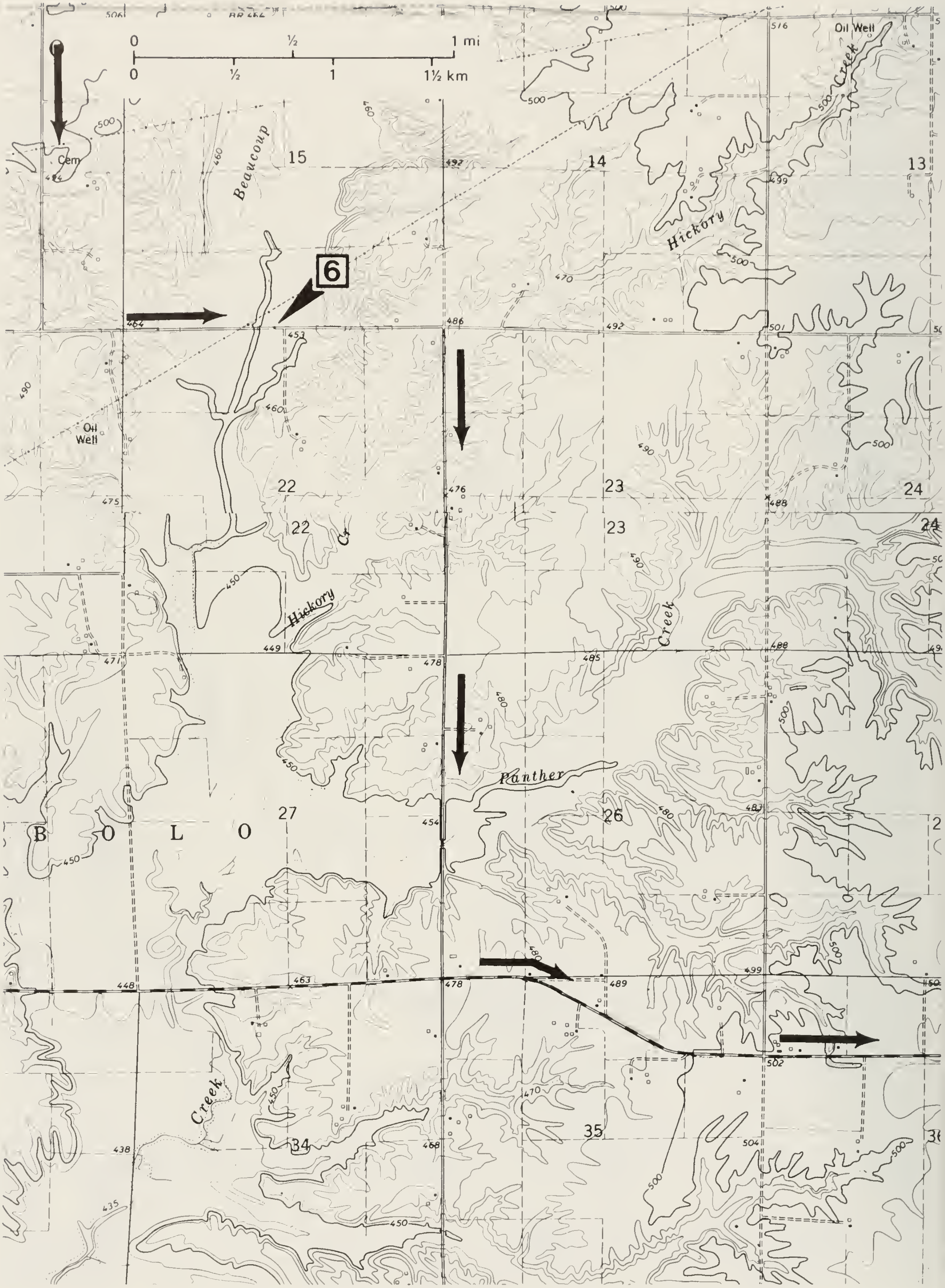
STATE CONSERVATION AREA
WASHINGTON COUNTY
Washington County Lake
Picnic Areas
Public Access
PIPELINES
B O L O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26
B O L O
Creek
34
35
500
460
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470
480
490

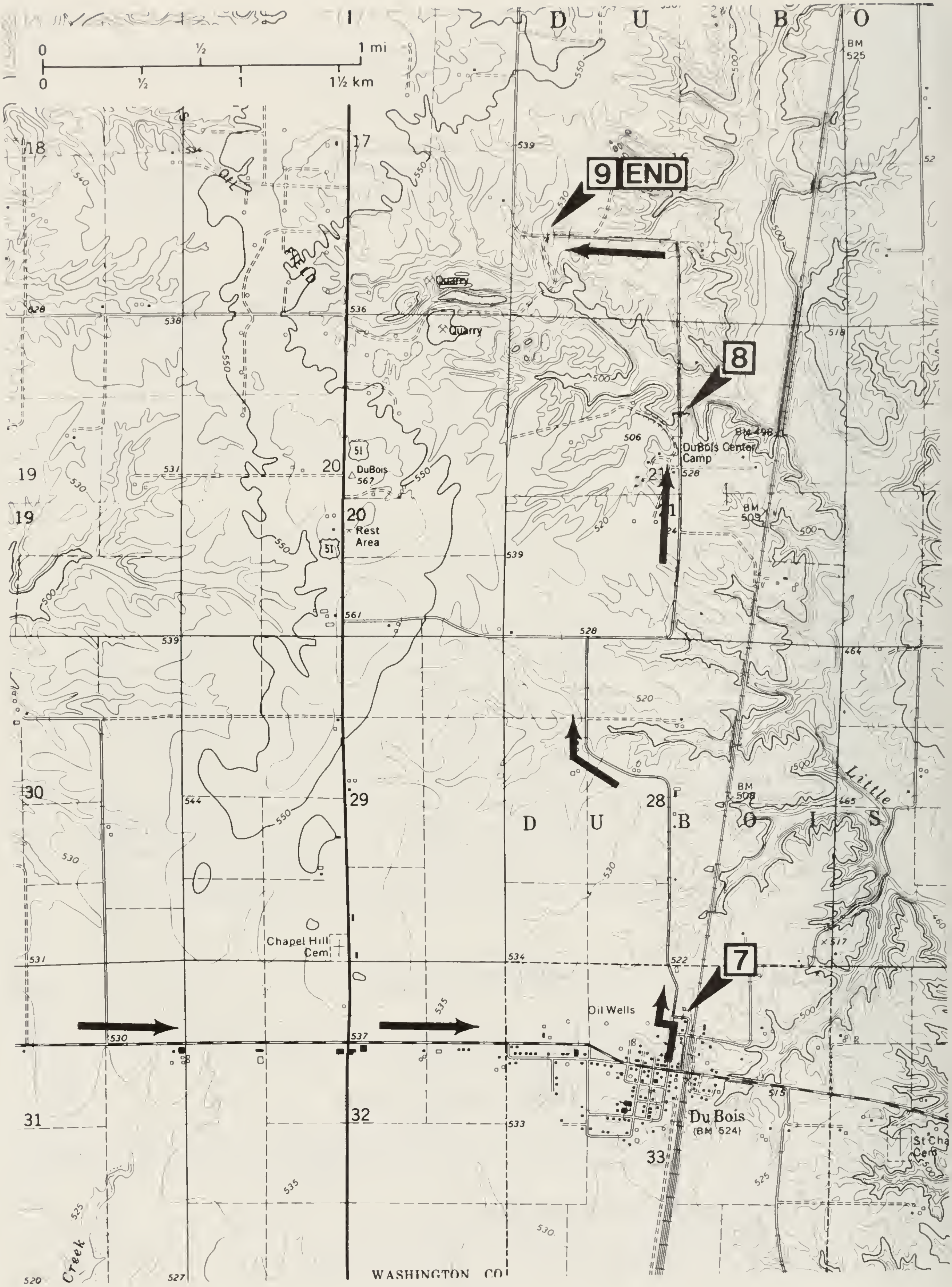
STOP 6 We will discuss the alluviated Beaucoup Creek valley (east side of Beaucoup Creek on south side of road; northwest extended NE NE NW Sec. 22, T3S, R2W, 3rd P.M., Washington County; Beaucoup 7.5-Minute Quadrangle [38089C3]).

Drainage routes were established across the Illinoian till plain as the ice melted. Water flowing from one low place to another across the gently undulating surface quickly established an irregular dendritic pattern (which appears similar to the veins in a leaf). Streams were actively lengthening themselves headward and cutting their channels downward; V-shaped valleys formed.

A change in this normal erosion cycle occurred several thousand years later during the melting of the Wisconsinan Woodfordian glaciers. Although these later glaciers did not extend this far south, glacial meltwater torrents gushing from them were so laden with rock and soil debris that they flooded and then blocked most tributaries of the master streams—in this case the Mississippi River. The Kaskaskia River a short distance to the north, was carrying large volumes of meltwater and outwash debris from the ice front many miles to the north. Large quantities of the outwash sand and gravel were deposited along its course. Drainage for the field trip area was southward through the Big Muddy drainage system which was not draining the melting Wisconsinan ice front. Its mouth was blocked by a debris dam, and the large Lake Muddy (Shaw 1915) formed upstream in its valley.

Because Beaucoup Creek is a south-flowing tributary to the Big Muddy River, it also was affected by Lake Muddy. Flooding of its valley stopped downcutting of its bed and the fine sediments settled out in the slackwater lake, eventually filling it. This resulted in a flat silty bottom fill over its older till and bedrock floor. When these slackwater lakes were completely full of sediment, the streams were high enough that they were able to flow over the tops of the outwash dams at their mouths. When water volumes and levels in the Mississippi River were lowered, the tributaries were able to renew downcutting. Here we are far enough upstream that the sediments formed a flat presently only a little more than 0.25 mile wide to a depth of 35 to 40 feet. However, terrace remnants along its course indicate that this valley must have had a greater depth of fill and thus was wider. Beaucoup Creek has incised its channel into these alluvial deposits. As it meanders slightly across the valley bottom, it scours out the fill. Downcutting appears to be more active in this area than about 11 miles south, near Pinckneyville, where the Beaucoup Creek valley bottom is nearly 0.75 mile wide and about 35 feet lower. At present, it is about 50 feet above its bedrock floor there. Its gradient (bed slope) is much less near Pinckneyville and the stream, therefore, is quite sluggish, having developed some fairly large meander loops across the valley bottoms. Downcutting is progressing quite slowly in this southern part of the course because its base level is the Big Muddy River a few miles farther south.

0.0	31.75+	Leave Stop 6 and CONTINUE AHEAD (east).
0.1	31.85+	To the right across a small tributary, erosion is producing a badlands topography in the exposed glacial till.
0.4+	32.25+	TURN RIGHT (south) at T-road intersection.
0.1	32.35+	In the roadcut to the right, the Quaternary deposits are slumping considerably.
1.5+	33.9+	Cross Panther Creek bridge.



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Rest
Area
DuBois Center
Camp
Chapel Hill
Cem
Oil Wells
Du Bois
(BM 524)
Little
Creek
WASHINGTON CO
BM
525
BM 498
BM
509
BM
508

0.4+	34.3+	STOP: 2-way at cross road. TURN LEFT (east).
3.6	37.9+	STOP: 2-way at intersection with US 51. CAUTION: fast cross traffic. CONTINUE AHEAD (east).
0.5	38.4+	CAUTION: enter Village of Du Bois.
0.55+	38.95+	TURN LEFT (north) on Front Street just BEFORE the Illinois Central Railroad crossing.
0.15+	39.15+	TURN LEFT (west) on Coal Street and prepare to park.
0.05-	39.2-	PARK along north side of Coal Street. Please do NOT block driveways. CAUTION: truck traffic.

STOP 7 We will discuss the Du Bois Coal Company shaft mine and the local geological structure (NW SW NW NE Sec. 33, T3S, R1W, 3rd P.M., Washington County; Tamaroa 7.5-Minute Quadrangle [38089B2]).

A company selling stone products now uses the old mine site for its current operations. The shaft site was close to the concrete bunker just to the north. This mine, known as the Kuhn Coalery Company at one time, was the oldest active coal mine in the state. It began operations just before 1865 when General Grant took Richmond, Virginia, and was idle a couple of years during the 1920s and then again during the early 1960s. The shaft was finally closed in 1966 after 101 years of operation.

The Herrin (No. 6) Coal Member of the Carbondale Formation (note generalized stratigraphic column on the Pennsylvanian-age rocks in *Depositional History of the Pennsylvanian Rocks in Illinois* in the appendix) had an average thickness of 5 feet 8 inches at a depth of 300 feet.

In its later years, the Du Bois Mine was a seasonal, cooperative operation run by about 30 miners who, despite being surrounded by the "big" coal companies of southern Illinois, found a ready market for the 140 tons of coal produced daily by the pick and shovel method. In addition to local truck trade, the mine shipped much of its annual output of 10,000 tons on the mainline of the Illinois Central Railroad (ICRR). The room and pillar mine layout plan was followed here; five pit mules were used to pull the 1 ton pit cars to the shaft bottom where a steam engine on the surface hoisted the coal topside. There was no electricity so the miners used open carbide lamps for illumination. No safety devices were used in this mine, which only had two fatalities in its long history; one from a premature powder blast underground and one on the surface from a ruptured steam line. No roof falls were ever reported.

A sign found about the time the mine closed showed World War I prices ranging from $4.25 per ton for 2-inch raw coal to $6.25 per ton for 6-inch lump coal. Total production tonnage figures are not available, but from 1939 through 1961, about 391,785 tons of coal were mined here.

Geologically this area is very interesting. In addition to the excellent roof conditions prevailing in this mine, a short way to the east is the Du Quoin Monocline. This structure, which is a steplike downfold in the bedrock, shows up well when plotting the position of the Herrin Coal. Here the coal is about 300 feet deep and at Waltonville, 9 miles to the east, it is about 800 feet deep. Prospect drilling has shown that the difference in depths is not along a gradual slope, which would be less than a 1° dip, but rather a sharp downfold in the strata.

0.0	39.2-	Leave Stop 7 and CONTINUE AHEAD (west).
0.05-	39.2+	CAUTION: yield at T-road intersection. TURN RIGHT (north).
0.85	40.05+	Note how rooting by pigs in the field to the right has enabled erosion to strip away the thin top soil, leaving a bare slope. In this type of situation, heavy rainfall not only causes much soil loss, but also results in siltation downslope in creeks and rivers.
0.5+	40.55+	CAUTION: unguarded T-road intersection. TURN RIGHT (east).
0.85	41.45+	Prepare to park just ahead.
0.1+	41.55+	PARK along road shoulder. CAUTION: deep ditch.

STOP 8 We will examine McLeansboro Group coal and associated strata exposed in the road cut in the south valley wall of an east-flowing tributary to Little Muddy River (east side of roadcut; NE NE SE NW Sec. 21, T3S, R1W, 3rd P.M., Washington County; Ashley 7.5-Minute Quadrangle [38089C2]).

Various geologists, beginning with Engelmann in the 1860s, have studied the Pennsylvanian bedrock strata exposed at and near the surface in Washington County, but detailed maps of these studies are not readily available. Some stratigraphic units are thin and difficult to identify by themselves. However, when several of them can be studied in a single exposure, and one or two are identified and properly placed in the stratigraphic sequence, some of the problems caused by correlating from widely spaced exposures can be solved or eliminated. The coal exposed here probably does not correlate with the Opdyke Coal (fig. 13) that is found about 5.5 miles to the east at Stop 3 on the Mt. Vernon field trip. Here the coal is more weathered but thicker than at Mt. Vernon Stop 3. The shale/claystone thickness is about the same, but if any limestone formerly was present here above the shale, it has been eroded away and no fragments of it are found nearby. The main similarity lies with the fossil plant fragments in the underclay, but no detailed comparisons were made. Samples of this coal have not been macerated for their plant spore assemblage. A study of these plant spores probably would make the identification of the coal possible. For now we will have to say only that it is some thin coal that occurs above the Shoal Creek Limestone Member of the Bond Formation.

The rocks exposed here belong to the
QUATERNARY SYSTEM
Pleistocene Series
Wisconsinan Stage
Woodfordian Substage

• Peoria Loess—medium brown with reddish cast; Modern Soil developed in it	1± ft
• silt—tan with grayish cast, becomes harder and blocky downward	1.25± ft

Illinoian Stage
Monican Substage
Glasford Formation

• till—yellowish brown with some gray mottling; weathered; pebbly throughout; a 3- to 4-inch stone line at the top contains chert, sandstone, and igneous fragments, some up to 2 inches thick	4.25± ft

McLeansboro Group

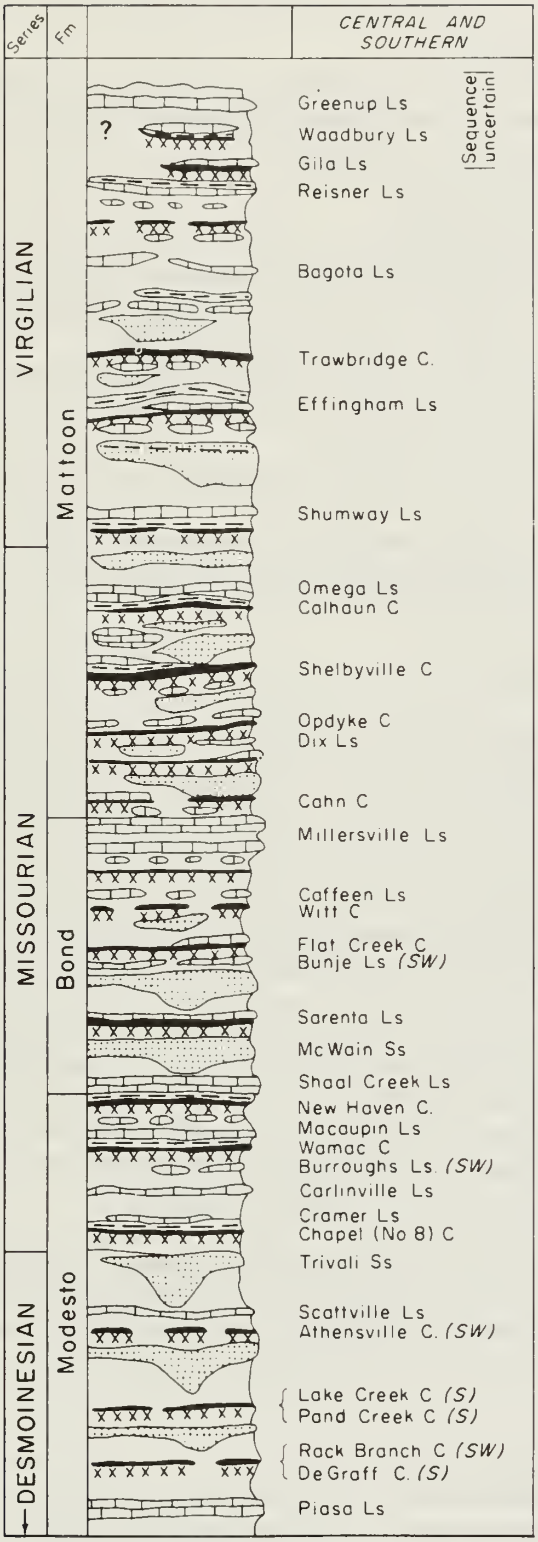

Figure 13 Classification of the McLeansboro Group of the Pennsylvanian System.

PENNSYLVANIAN SYSTEM
McLeansboro Group
Missourian Series
Bond Formation (??)

• claystone—gray; soft; semblance of bedding gets better downward and shows up better on weathered surface where rain has etched it out	3± ft
• shale—medium gray with brownish cast; thin bedded	1.25± ft
• shale—brown; blocky	5 in.
• coal—soft; weathered	1+ ft
• underclay—brownish; top 2± inches with "yellow boy"	7 in.
• underclay—gray; blocky; silty; carbonized plant fragments throughout with a 3/8-inch coal streak near the base	1.25 ft
• claystone—similar to above with plant debris but has some semblance of bedding; top 7 inches is brown; becomes olive-gray downward; base concealed	2.33+ ft

---

0.0	41.55+	Leave Stop 8 and CONTINUE AHEAD (north).
0.1+	41.65+	Cross tributary to Little Muddy River.
0.7	42.35+	Prepare to park just ahead.
0.1+	42.5	PARK along the roadside without blocking any driveways or field entrances. You MUST HAVE PERMISSION to enter these premises.

STOP 9 We will examine blocks of the Pennsylvanian Shoal Creek Limestone Member of the Bond Formation at the abandoned crusher site of the Jax Asphalt's Pitts Quarry (entrance, south side of road, near northeast corner NW NW SW SW Sec. 16, T3S, R1W, 3rd P.M., Washington County; Ashley 7.5-Minute Quadrangle [38089C2]).

Until it ceased operating recently, Pitts Quarry was the only active quarry in Washington County. The limestone quarried was the Shoal Creek which lies about 360 feet above the Herrin (No. 6) Coal. Although the limestone is only 6 to 7 feet thick, it was economical to quarry the stone because other operating stone quarries were distant from this area. Transportation costs quickly exceed production costs the farther you get from the source of a high-bulk commodity such as a construction aggregate or agricultural lime.

All of the former operating pits are full of water, so we can no longer examine the rocks that were exposed here. Our description of the section is based on one used by Wilson, Odom, and Hanagan (1958) and modified by Wanless, Frye, Willman, and Leonard (field notes).

QUATERNARY SYSTEM
Pleistocene Series
Wisconsinan Stage
Woodfordian Substage

• Peoria Loess—modern soil developed in the loess	2-3 ft

Illinoian Stage

Monican Substage

• till—tan and mottled in upper weathered part; gray and blue-gray in lower part, blocky, compact, pebbly to bouldery, leached	6 ft
• till—tan and gray; oxidized and partly leached	2 ft
• gravel, sand, silt with some clay—tan and brown; massive but with indistinct zonation; leached in upper quarter, calcareous below	3 in.
• till—tan to gray; extremely hard and compact; jointed	3-5 ft
• gravel—partially cemented; clayey	8 in.
• till—tan (oxidized); calcareous; hard and compact; massive; pebbly with many ironstone concretions from the underlying shale	5 ft

PENNSYLVANIAN SYSTEM
McLeansboro Group
Missourian Series
Bond Formation

• shale—gray; fossiliferous (crinoids and brachiopods); contains ironstone concretions	4-6 ft
• Shoal Creek Limestone Member—gray; dense; massively bedded but weathers flaggy; fossiliferous (brachiopods and many crinoids)	6-7 ft
• shale—gray; fossiliferous	1 ft
• shale—black; slaty	3 ft
• shale—gray to black; structureless	1 ft

A small anticline (arch) was exposed in this quarry. This was not surprising, as this location is only a short distance west of the Du Duoin Monocline, which trends approximately north to south. This anticline trends northwest to southeast roughly paralleling the larger oil-yielding anticlines discussed at Stop 4.

At this location, we will have the opportunity to examine the system of land surveys in Illinois. As the 15- and 7.5-minute quadrangles show, section lines do not form an even grid pattern over the whole field trip area. You will note that some sections are considerably larger or smaller than others. Some sections are misshapen because of slanted section and quarter-section lines.

In 1804, initial surveying from the 2nd P.M. (fig. 14) continued westward from Vincennes, Indiana and became the basis for surveying about 10 percent of what is now eastern Illinois. Because the western boundary of this tract had not been established with certainty, it was decided in 1805 to designate the 3rd P.M. as beginning at the mouth of the Ohio River and extending northward to facilitate surveying new land accessions. By late 1805 a base line had been run east to the Wabash River and west to the Mississippi River from the 3rd P.M. During March 1806, surveying commenced northward on both sides of the 3rd P.M. After the selection of an initial point from which to establish a base line and lay out the surveys, the line was moved northward 36 miles, where it roughly coincides with the base line of the 2nd P.M.

The township and range system permits the accurate identification of most parcels of land in Illinois to facilitate the sale and transfer of public and private lands. In the early 1800s, each township was divided (to the best of the surveyor's ability) into 36 sections, each 1 mile square and containing 640 acres (see route maps).

Township and range lines in figure 15 do not form a perfect rectangular grid over the state because different base lines and principal meridians were used, and because minor offsets

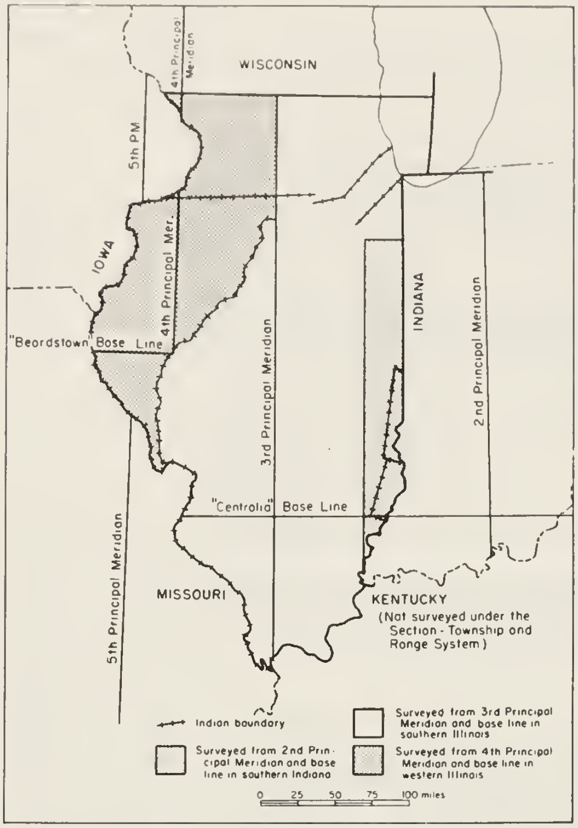

Figure 14 Principal meridians and base lines of Illinois and surrounding states (Cote 1978).

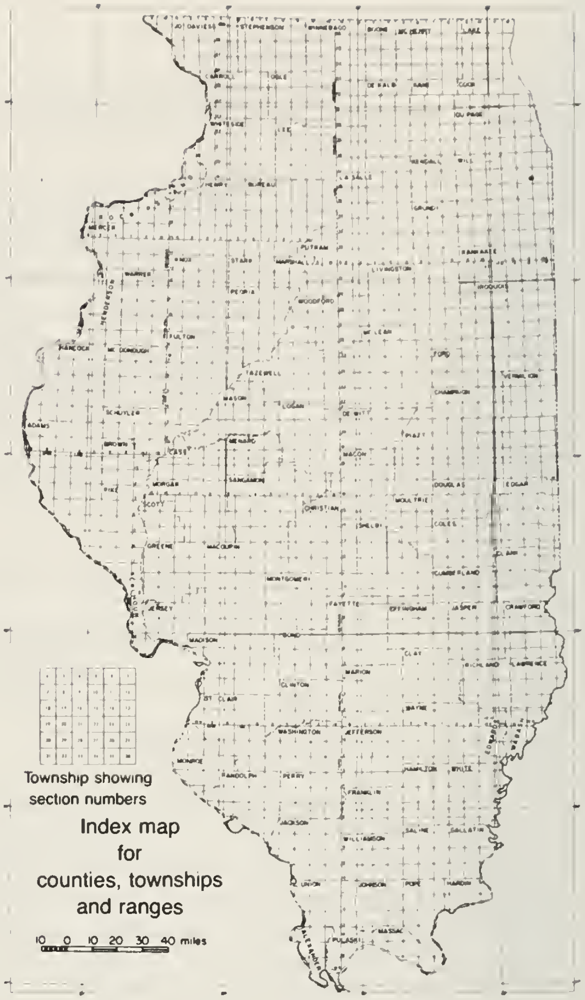

Figure 15 Index map (Cote 1978).

were necessary to compensate for the earth's curvature. The surveying corrections producing the minor offsets were usually made at regular intervals of about 30 miles. Figure 15 shows what happened when the survey from the 2nd P.M. met the survey from the 3rd P.M. From Iroquois County south to White County, only narrow partial townships could be made where the two surveys met. These partial townships are all located in R11E, 3rd P.M., and in most places, are less than one section wide.

Closer at hand, note the top tier of sections in T3S R3W as mentioned in the road log (between Stops 2 and 3) and the right tier of sections along the 3rd P.M. in T2S. The 3rd P.M. is situated 3.9 miles east of this stop. (Question: *if* all the townships between this stop and the last stop on the September Oregon field trip are *exactly* 6 miles long on their border with the 3rd P.M., how far south are we from Oregon Stop 8? How far west of Oregon Stop 8 are we here at Nashville Stop 9? Answers: Oregon Stop 8 is on the north line of the bottom tier of sections equal to T41N; therefore, it is 40 x 6 + 1 = 241 miles north of the base line and 1.2 miles west of the 3rd P.M. We are 14.75 miles south of the base line; therefore, we are 255.75 miles south and 2.7 miles west of Oregon Stop #8 according to the ideal township and section measurements.)

Get out your quadrangle maps and have some fun. If your supply of topographic maps is limited, the Illinois State Geological Survey will furnish you with a free index to the topographic maps of Illinois. When you decide which maps you can use, you may purchase them from the Survey. ——*End of trip. Join us for the next field trip in the spring.*

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MISSISSIPPIAN DEPOSITION

(The following quotation is from Report of Investigations 216: Classification of Genevievian and Chesterian...Rocks of Illinois [1965] by D. H. Swann, pp. 11-16. One figure and short sections of the text are omitted.)

During the Mississippian Period, the Illinois Basin was a slowly subsiding region with a vague north-south structural axis. It was flanked by structurally neutral regions to the east and west, corresponding to the present Cincinnati and Ozark Arches. These neighboring elements contributed insignificant amounts of sediment to the basin. Instead, the basin was filled by locally precipitated carbonate and by mud and sand eroded from highland areas far to the northeast in the eastern part of the Canadian Shield and perhaps the northeastward extension of the Appalachians. This sediment was brought to the Illinois region by a major river system, which it will be convenient to call the Michigan River (fig. 4) because it crossed the present state of Michigan from north to south or northeast to southwest....

The Michigan River delivered much sediment to the Illinois region during early Mississippian time. However, an advance of the sea midway in the Mississippian Period prevented sand and mud from reaching the area during deposition of the St. Louis Limestone. Genevievian time began with the lowering of sea level and the alternating deposition of shallow-water carbonate and clastic units in a pattern that persisted throughout the rest of the Mississippian. About a fourth of the fill of the basin during the late Mississippian was carbonate, another fourth was sand, and the remainder was mud carried down by the Michigan River.

Thickness, facies, and crossbedding...indicate the existence of a regional slope to the southwest, perpendicular to the prevailing north 65° west trend of the shorelines. The Illinois Basin, although developing structurally during this time, was not an embayment of the interior sea. Indeed, the mouth of the Michigan River generally extended out into the sea as a bird-foot delta, and the shoreline across the basin area may have been convex more often than concave.

....The shoreline was not static. Its position oscillated through a range of perhaps 600 to 1000 or more miles. At times it was so far south that land conditions existed throughout the present area of the Illinois Basin. At other times it was so far north that there is no suggestion of near-shore environment in the sediments still preserved. This migration of the shoreline and of the accompanying sedimentation belts determined the composition and position of Genevievian and Chesterian rock bodies.

Lateral shifts in the course of the Michigan River also influenced the placement of the rock bodies. At times the river brought its load of sediment to the eastern edge of the basin, at times to the center, and at times to the western edge. This lateral shifting occurred within a range of about 200 miles. The Cincinnati and Ozark areas did not themselves provide sediments, but, rather, the Michigan River tended to avoid those relatively positive areas in favor of the down-warped basin axis.

Sedimentation belts during this time were not symmetrical with respect to the mouth of the Michigan River. They were distorted by the position of the river relative to the Ozark and Cincinnati shoal areas, but of greater importance was sea current or drift to the northwest. This carried off most of the mud contributed by the river, narrowing the shale belt east of the river mouth and broadening it west

of the mouth. Facies and isopach maps of individual units show several times as much shale west of the locus of sand deposition as east of it. The facies maps of the entire Chesterian...show maximum sandstone deposition in a northeast-southwest belt that bisects the basin. The total thickness of limestone is greatest along the southern border of the basin and is relatively constant along that entire border. The proportion of limestone, however, is much higher at the eastern end than along the rest of the southern border, because little mud was carried southeastward against the prevailing sea current. Instead, the mud was carried to the northwest and the highest proportion of shale is found in the northwestern part of the basin.

Genevievian and Chesterian seas generally extended from the Illinois Basin eastward across the Cincinnati Shoal area and the Appalachian Basin. Little terrigeneous sediment reached the Cincinnati Shoal area from either the west or the east, and the section consists of thin limestone units representing all or most of the major cycles. The proportion of inorganically precipitated limestone is relatively high and the waters over the shoal area were commonly hypersaline... Erosion of the shoal area at times is indicated by the presence of conodonts eroded from the St. Louis Limestone and redeposited in the lower part of the Gasper Limestone at the southeast corner of the Illinois Basin...

The shoal area included regions somewhat east of the present Cincinnati axis and extended from Ohio, and probably southeastern Indiana, through central and east-central Kentucky and Tennessee into Alabama....

Toward the west, the seaway was commonly continuous between the Illinois Basin and central Iowa, although only the record of Genevievian and earliest Chesterian is still preserved. The seas generally extended from the Illinois and Black Warrior regions into the Arkansas Valley region, and the presence of Chesterian outliers high in the Ozarks indicates that at times the Ozark area was covered. Although the sea was continuous into the Ouachita region, detailed correlation of the Illinois sediments with the geosynclinal deposits of this area is difficult.

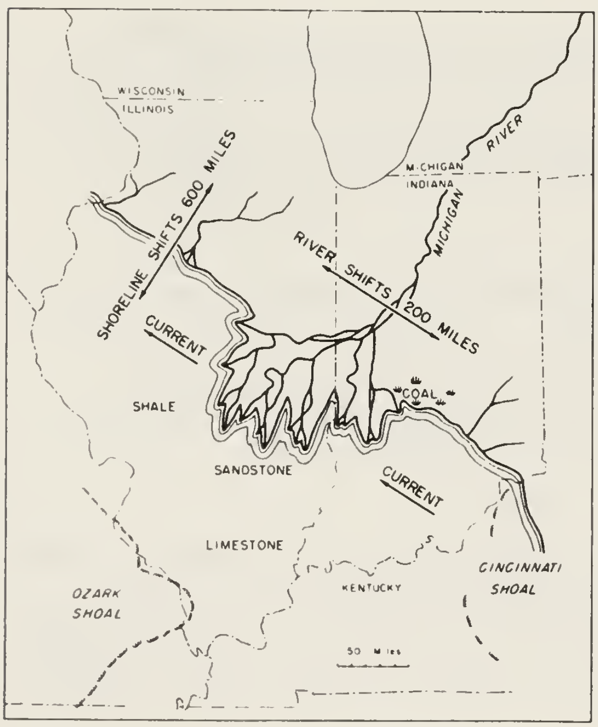

Figure 4: Paleogeography at an intermediate stage during Chesterian sedimentation.

THE TYPICAL MISSISSIPPIAN CHESTERIAN SERIES IN SOUTHWESTERN ILLINOIS

REPRESENTED BY
A COMPOSITE COLUMN AND AN ELECTRIC LOG

The composite column on the following page (RI 216, Pl 1) is a diagram drawn to represent certain rocks layers as they appear in a part of southwestern Illinois. The electric log (e-log) is a record made from instrument observations and recordings of rock layers in the bore of an oil-test well. A geologist made the column, using symbols to briefly express the significant rock unit qualities he could observe. In contrast, the e-log was made by an electrical sensing device lowered and raised in the test well to measure only two specific qualities of the rock layers: resistivity and spontaneous-potential. Together, the correlated column and e-log show in a concise way what the isolated outcrops in the area cannot, i.e., what thicknesses, variations in lithology, and mutual relations the sub-divisions of the Chesterian Series have across the country. In addition, the correlated e-log is a key that may be used to interpret other e-logs in this part of the Illinois Basin.

Cross-sections consisting of several corrlelated e-logs reproduced at the same scale are used to demonstrate that: (1) thicker layers of sandstone or shale or limestone--a particular rock unit--are delineated as characteristic shapes by the pair of S-P and resistivity curves, (2) the rock units vary in thickness and composition from one place to another, but many points of similarity persist (the unique curves of some units persist for several hundred miles), and (3) the seemingly abstract curves of the e-log create a pciture in many ways as readable as other illustrations of rock columns.

Because Illinois has been a major oil producer for many years, tens of thousands of e-logs have been made of wells drilled throughout the state. They are the principal tool of the geologists who map deep subsurface geological units (rock layers) and structures, such as anticlines, synclines, monoclinal folds, domes, etc. Because of their value, e-logs and other types of well logs are filed as permanent records at the Illinois State Geological Survey, where they may be examined. NOTE: copies of e-logs may be purchased from companies that reproduce them.

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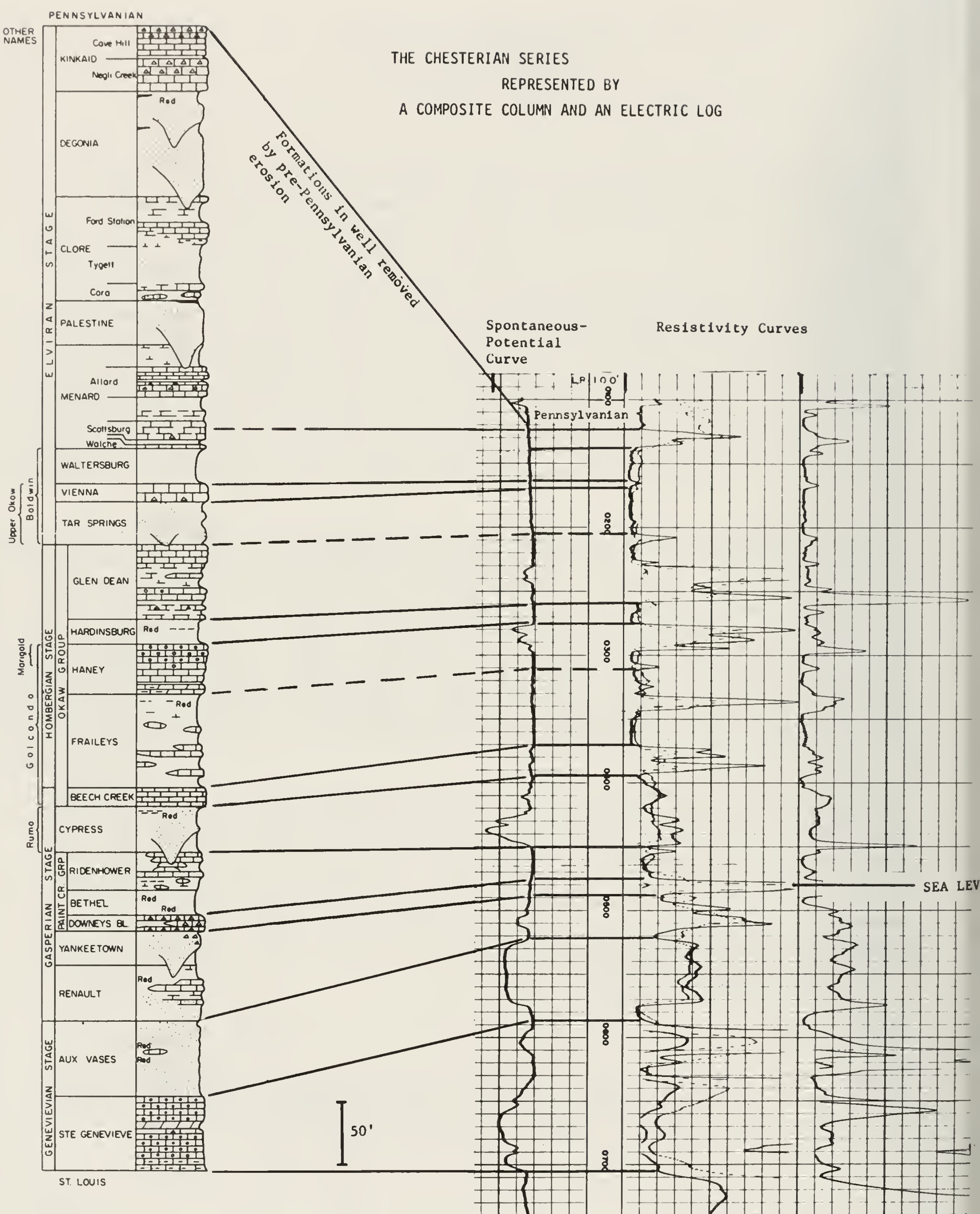
THE CHESTERIAN SERIES
REPRESENTED BY
A COMPOSITE COLUMN AND AN ELECTRIC LOG



DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS IN ILLINOIS

At the close of the Mississippian Period, about 310 million years ago, the sea withdrew from the Midcontinent region. A long interval of erosion that took place early in Pennsylvanian time removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. Ancient river systems cut deep channels into the bedrock surface. Later, but still during early Pennsylvanian (Morrowan) time, the sea level started to rise; the corresponding rise in the base level of deposition interrupted the erosion and led to filling the valleys in the erosion surface with fluvial, brackish, and marine sands and muds.

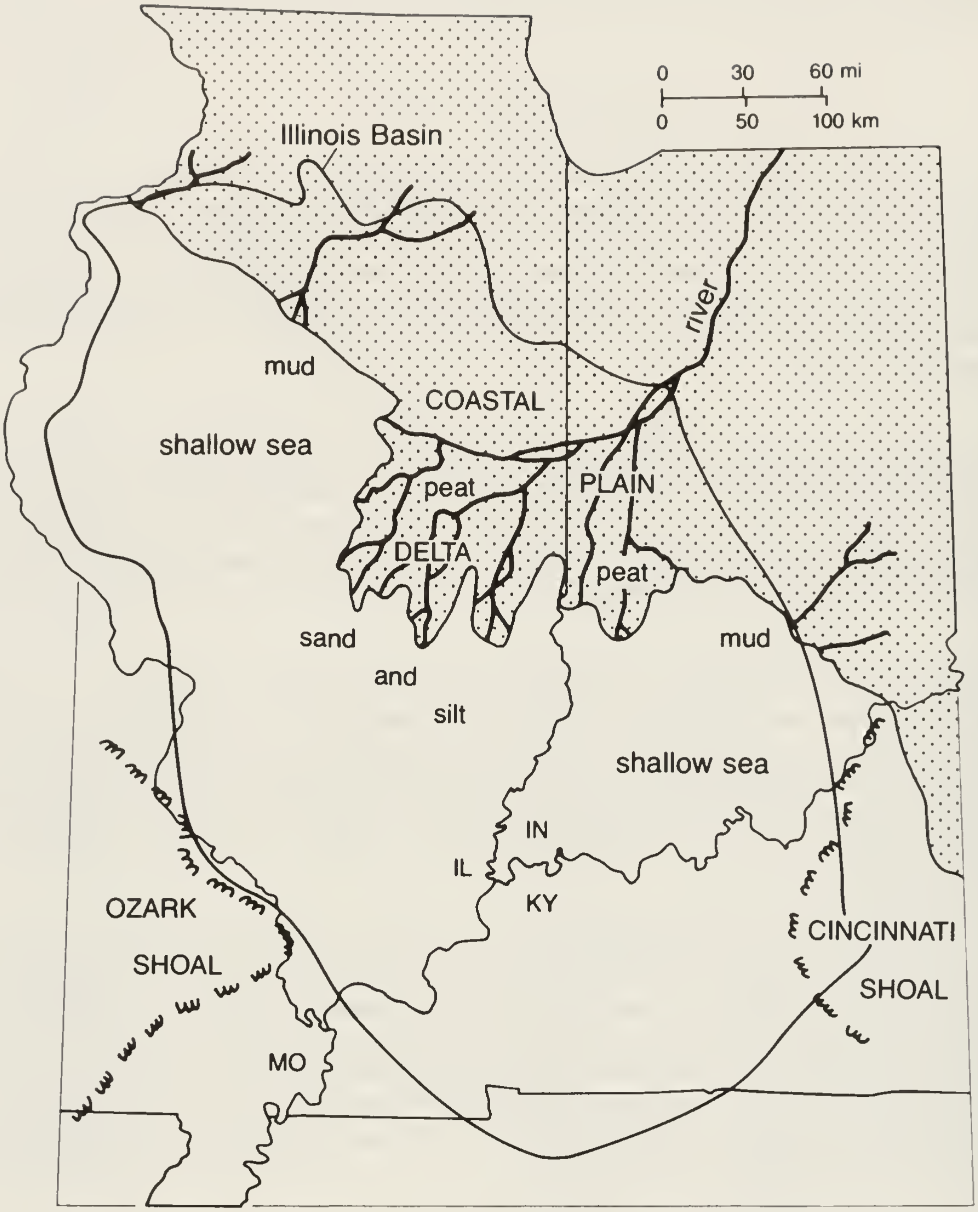
Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those of the preceding Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands to the northeast. This river system formed thin but widespread deltas that coalesced into a vast coastal plain or lowland that prograded (built out) into the shallow sea that covered much of present-day Illinois (see paleogeographic map, next page). As the lowland stood only a few feet above sea level, slight changes in relative sea level caused great shifts in the position of the shoreline.

During most of Pennsylvanian time, the Illinois Basin gradually subsided; a maximum of about 3000 feet of Pennsylvanian sediments are preserved in the basin. The locations of the delta systems and the shoreline of the resulting coastal plain shifted, probably because of worldwide sea level changes, coupled with variation in the amounts of sediments provided by the river system and local changes in basin subsidence rates. These frequent shifts in the coastline position caused the depositional conditions at any one locality in the basin to alternate frequently between marine and nonmarine, producing a variety of lithologies in the Pennsylvanian rocks (see lithology distribution chart).

Conditions at various places on the shallow sea floor favored the deposition of sand, lime mud, or mud. Sand was deposited near the mouths of distributary channels, where it was reworked by waves and spread out as thin sheets near the shore. Mud was deposited in quiet-water areas — in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Limestone was formed from the accumulation of limy parts of plants and animals laid down in areas where only minor amounts of sand and mud were being deposited. The areas of sand, mud, and limy mud deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sand, mud, and lime mud were deposited on the coastal plain bordering the sea. The nonmarine sand was deposited in delta distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies 100 or more feet thick were deposited in channels that cut through the underlying rock units. Mud was deposited mainly on floodplains. Some mud and freshwater lime mud were deposited locally in fresh-water lakes and swamps.

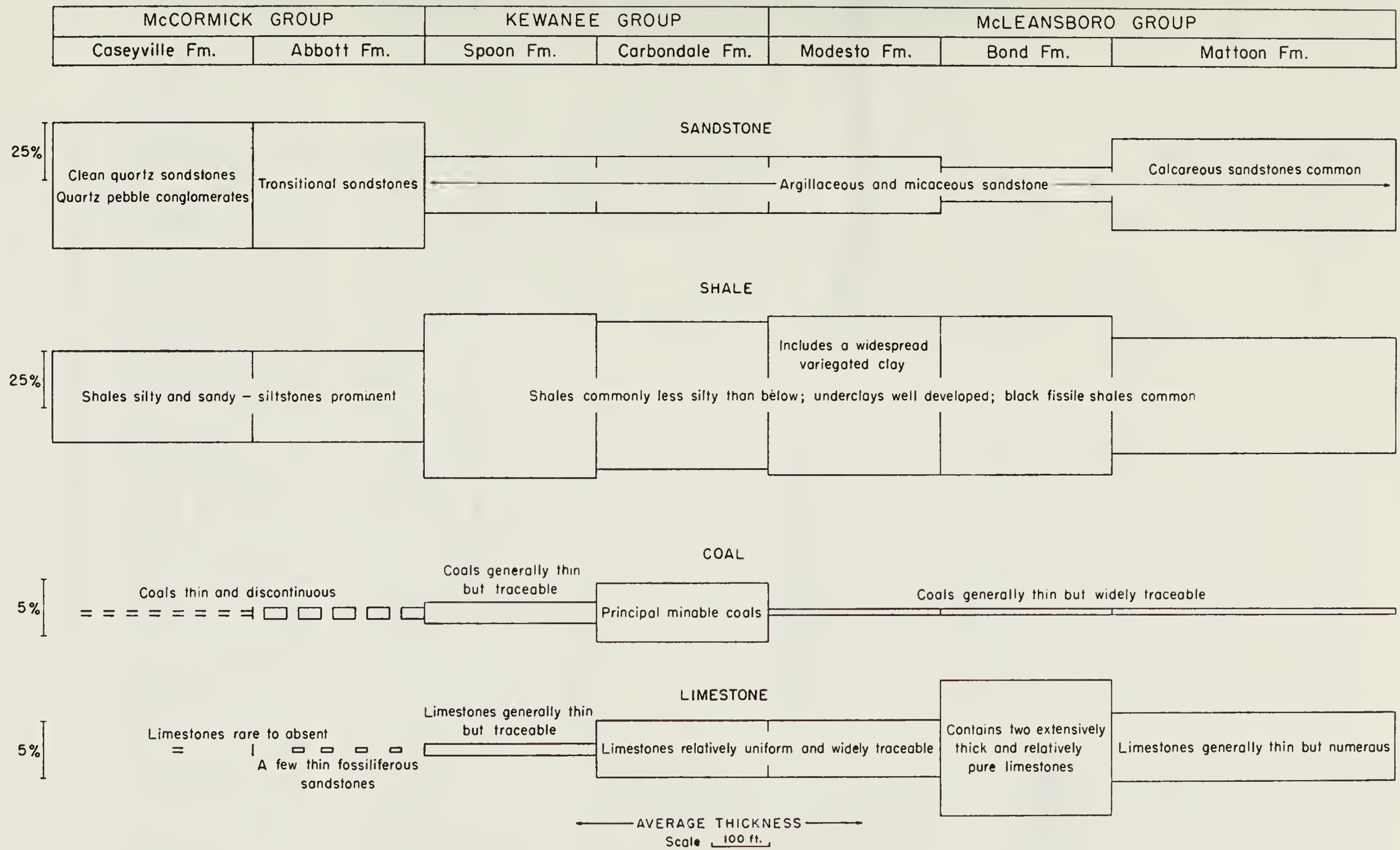
Beneath the quiet water of extensive swamps that prevailed for long intervals on the emergent coastal lowland, peat was formed by accumulation of plant material. Lush forest vegetation covered the region; it thrived in the warm, moist Pennsylvanian-age climate. Although the origin of the underclays beneath the coal is not precisely known, most evidence indicates that they were deposited in the swamps as slackwater mud before the accumulation of much plant debris. The clay underwent modification to become the soil upon which the lush vegetation grew in the swamps. Underclay frequently contains plant roots and rootlets that appear to be in their original places. The vast swamps were the culmination of nonmarine deposition. Resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were laid down over the peat.



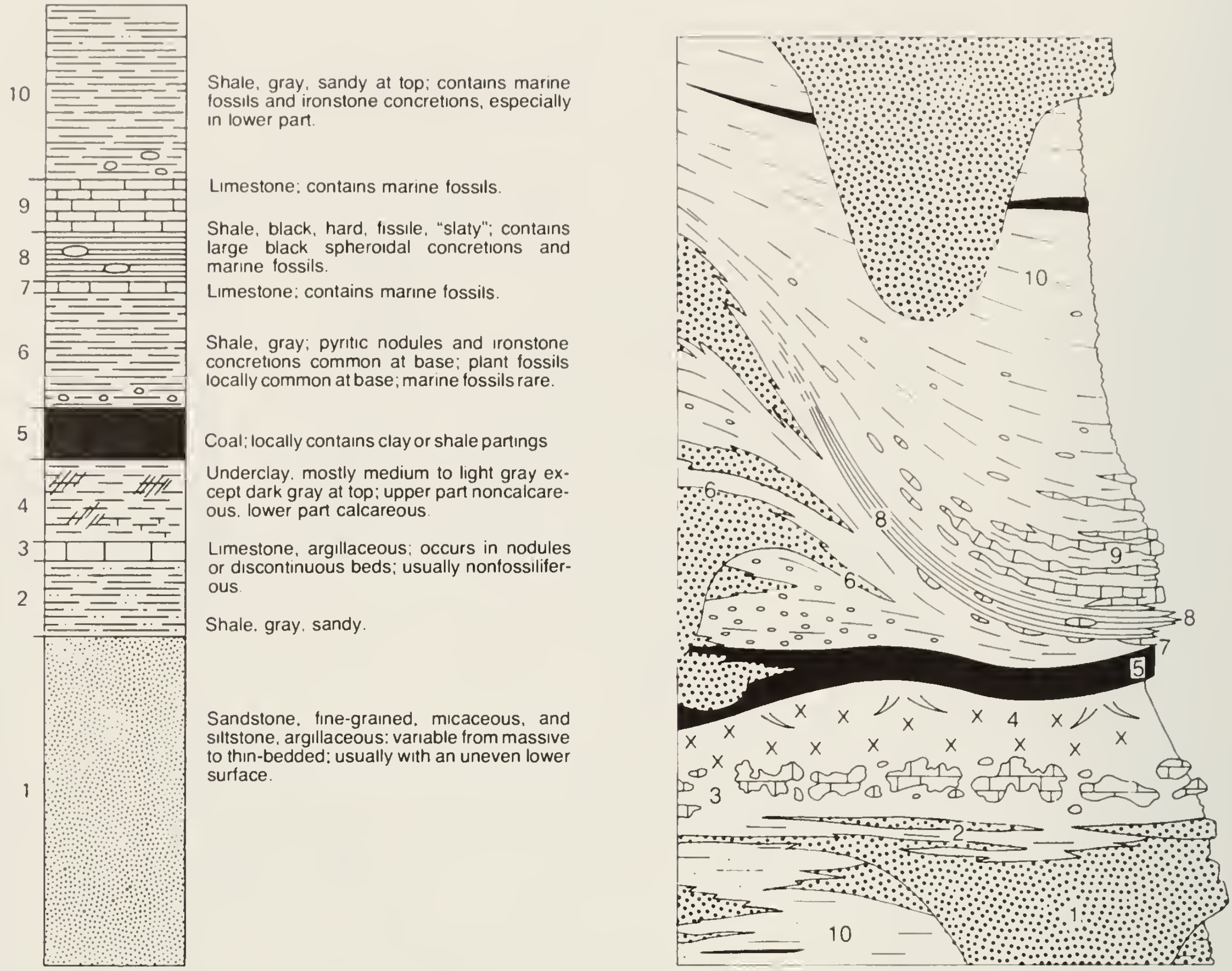
Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows a Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

Pennsylvanian Cyclothems

The Pennsylvanian strata exhibit extraordinary variations in thickness and composition both laterally and vertically because of the extremely varied environmental conditions under which they formed. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and some limestones, however, display remarkable lateral continuity for such thin units. Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.



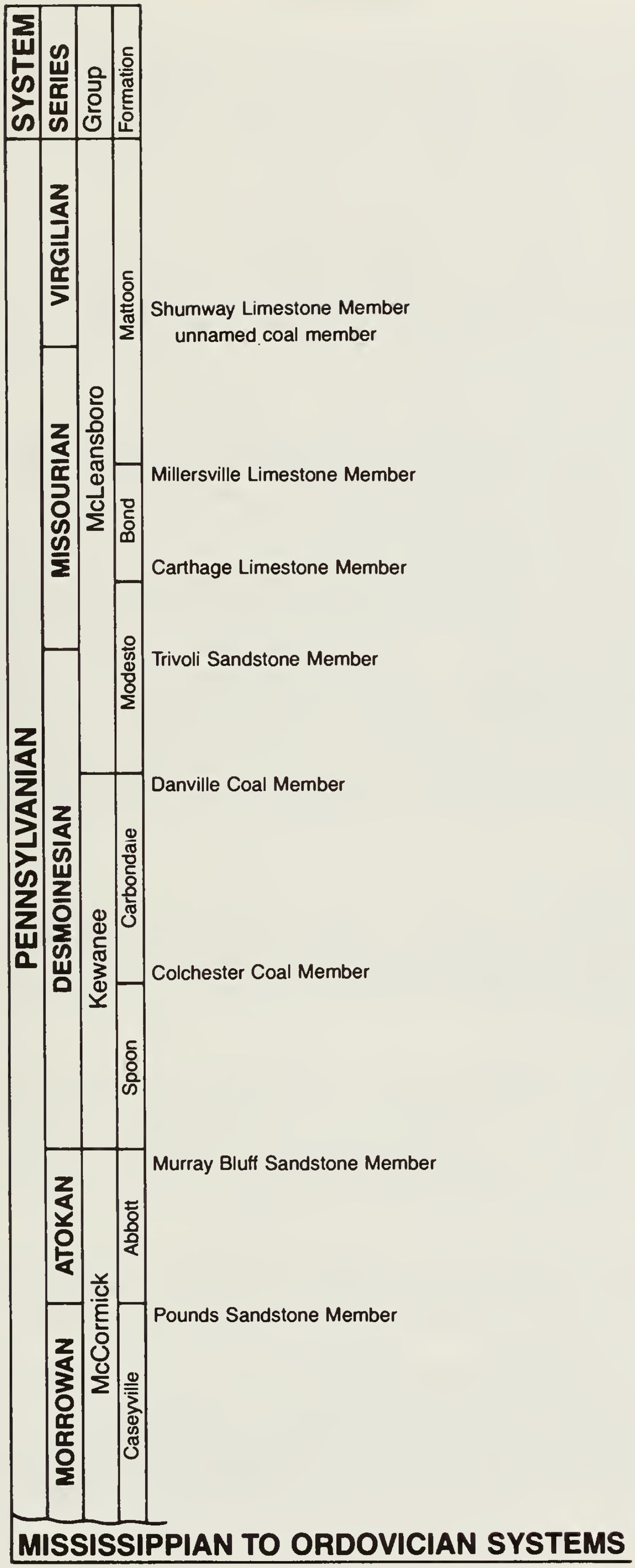
General distribution of the four principal lithologies in Pennsylvanian strata of Illinois.



The idealized cyclothem at left (after Willman and Payne, 1942) infers continuous, widespread distribution of individual cyclothem units, at right the model of a typical cyclothem (after Baird and Shabica, 1980) shows the discontinuous nature of many units in a cyclothem.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting shoreline. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an "ideally" complete cyclothem consists of ten sedimentary units (see illustration above contrasting the model of an "ideal" cyclothem with a model showing the dynamic relationships between the various members of a typical cyclothem).

Approximately 50 cyclothems have been described in the Illinois Basin but only a few contain all ten units at any given location. Usually one or more are missing because conditions of deposition were more varied than indicated by the "ideal" cyclothem. However, the order of units in each cyclothem is almost always the same: a typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal-gray shale portion (the lower six units) of each cyclothem is nonmarine: it was deposited as part of the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal and gray shale are marine sediments deposited when the sea advanced over the coastal plain.



Generalized stratigraphic column of the Pennsylvanian in Illinois (1 inch = approximately 250 feet).

Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothems. The swamps occupied vast areas of the coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm, humid Pennsylvanian climate. (Illinois at that time was near the equator.) The deciduous trees and flowering plants that are common today had not yet evolved. Instead, the jungle-like forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate (tropical). Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

Plant debris from the rapidly growing swamp forests — leaves, twigs, branches, and logs — accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented oxidation, and any decay of the peat deposits was due primarily to bacterial action.

The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests, and the peat deposits were often buried by marine sediments. After the marine transgressions, peat usually became saturated with sea water containing sulfates and other dissolved minerals. Even the marine sediments being deposited on the top of the drowned peat contained various minerals in solution, including sulfur, which further infiltrated the peat. As a result, the peat developed into a coal that is high in sulfur. However, in a number of areas, nonmarine muds, silts, and sands from the river system on the coastal plain covered the peat where flooding broke through levees or the river changed its coarse. Where these sediments (unit 6 of the cyclothem) are more than 20 feet thick, we find that the coal is low in sulfur, whereas coal found directly beneath marine rocks is high in sulfur. Although the seas did cover the areas where these nonmarine, fluvial sediments covered the peat, the peat was protected from sulfur infiltration by the shielding effect of these thick fluvial sediments.

Following burial, the peat deposits were gradually transformed into coal by slow physical and chemical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coal-forming ("coalification") process, and the peat deposits were changed into coal.

Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shale that occurs above many coals is uncertain. Current thinking suggests that the black shale actually represents the deepest part of the marine transgression. Maximum transgression of the sea, coupled with upwelling of ocean water and accumulation of mud and animal remains on an anaerobic ocean floor, led to the deposition of black organic mud over vast areas stretching from Texas to Illinois. Deposition occurred in quiet-water areas where the very fine-grained iron-rich

mud and finely divided plant debris were washed in from the land. Most of the fossils found in black shale represent planktonic (floating) and nektonic (swimming) forms — not benthonic (bottom-dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shale formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient water of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.

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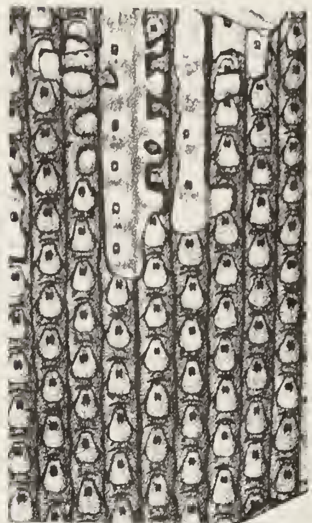
Common Pennsylvanian plants: lycopods, sphenophytes, and ferns

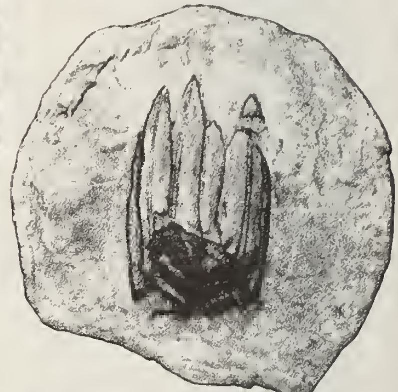
Lepidodendron aculeatum X0.8

Lepidophloios laricinus X0.63

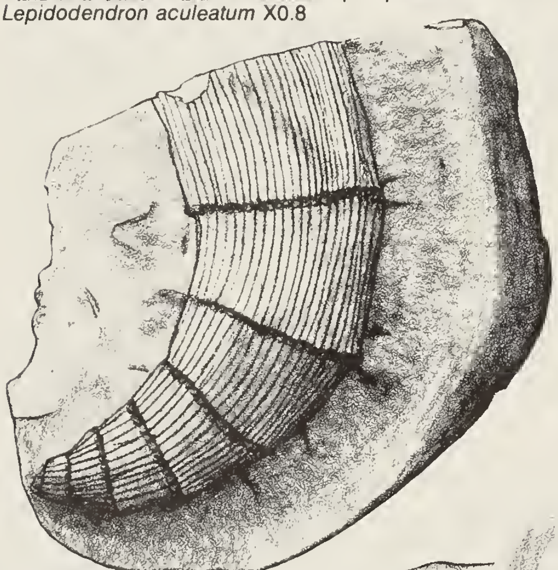


Sigillaria mammilaris X0.5

Stigmaria ficoides X0.32



Lepidostrobus ovatifolius X0.8



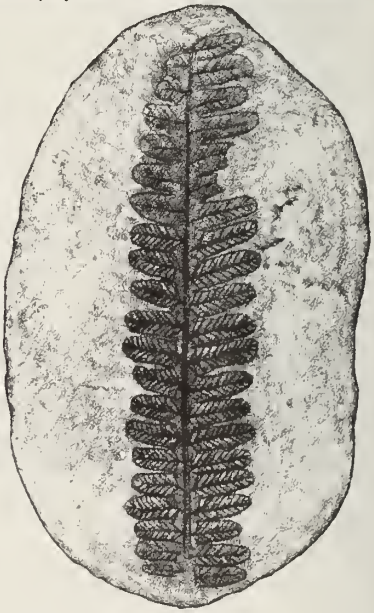
Calamites suckowii X0.5

Annularia stellata X0.63

Sphenophyllum cuneifolium X0.4

Pecopteris sp. X0.32

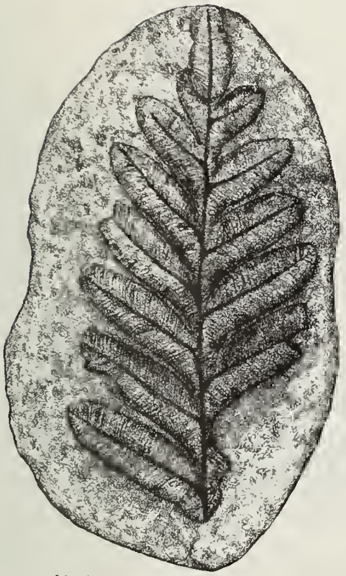
Pecopteris miltonii X2.0



Pecopteris hemitelioides X1.0

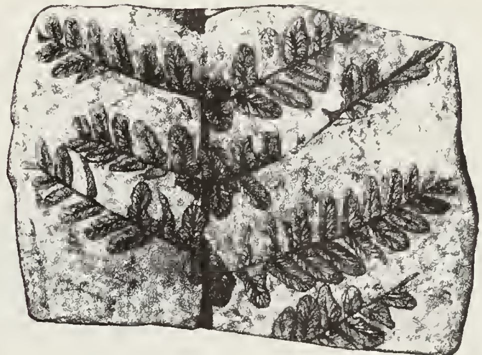
J. R. Jennings, ISGS

Common Pennsylvanian plants: seed ferns and cordaiteans



Alethopteris serlii X0.63

Alethopteris ambigua X0.63

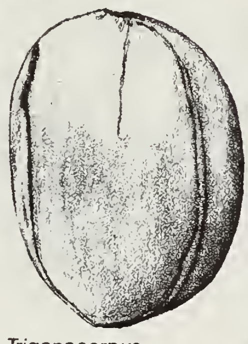


Neuropteris rarinervis X0.5

Mariopteris nervosa X0.8

Neuropteris scheuchzeri X0.63

Sphenopteris rotundiloba X0.8



Trigonocarpus parkinsonii X1.25

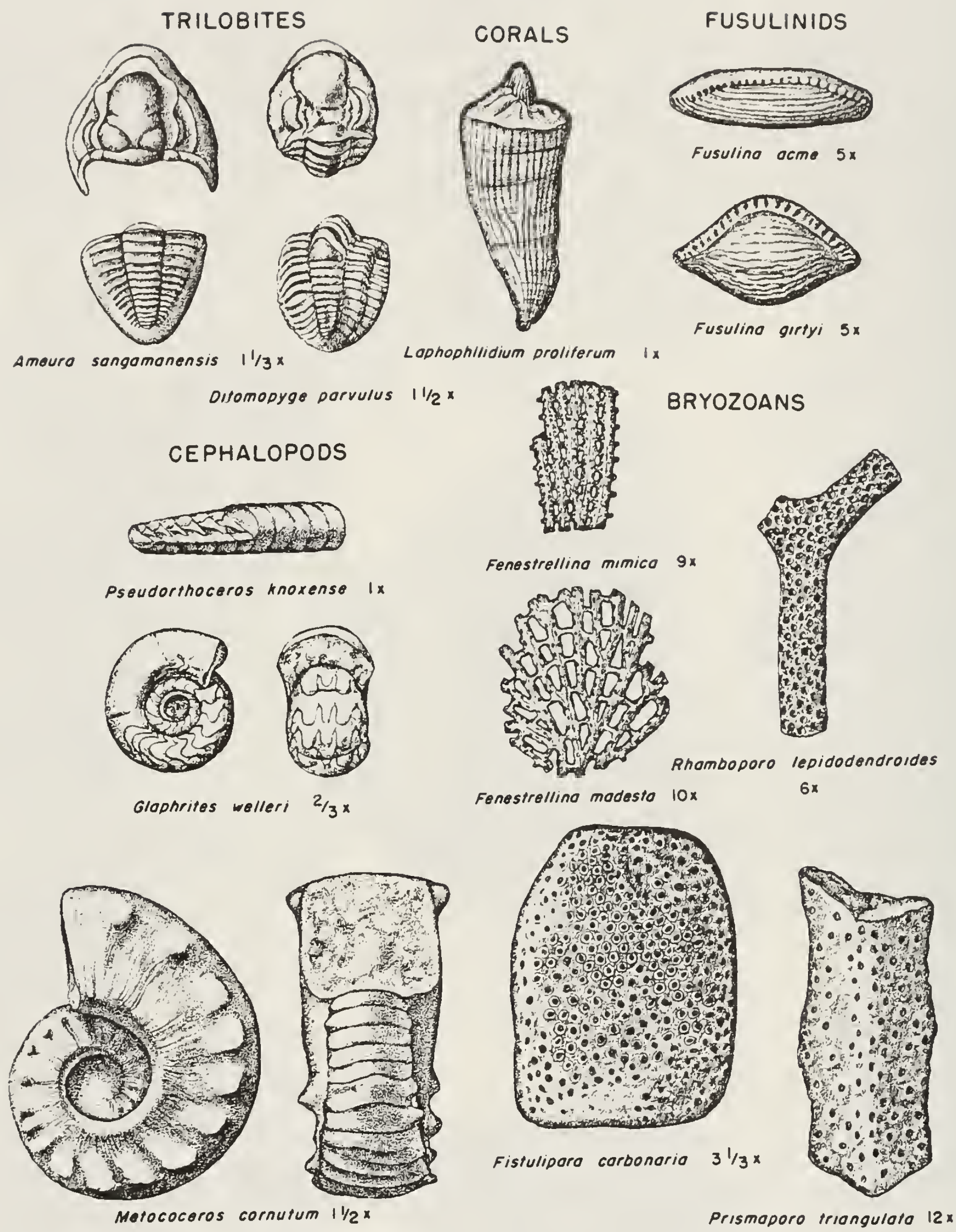
Cordaites principalis X0.63

Cordaicladus sp. X1.0

Artisia transversa X0.63

Cordaicarpon major X2.0

J. R. Jennings, ISGS


TRILOBITES
CORALS
FUSULINIDS
Fusulina acme 5x
Fusulina girtyi 5x
Ameura sangamanensis 1 1/3 x
Lophophllidium proliferum 1x
Ditomopyge parvulus 1 1/2 x
BRYOZOANS
CEPHALOPODS
Fenestrellina mimica 9x
Pseudorthoceras knoxense 1x
Rhombopora lepidodendroides 6x
Glaphrites welleri 2/3 x
Fenestrellina modesta 10x
Fistulipora carbonaria 3 1/3 x
Metacoceras cornutum 1 1/2 x
Prismopora triangulata 12x

PELECYPODS

Nucula (Nuculopsis) girtyi 1x

Edmania ovata 2x

Astartella concentrica 1x

Dunbarella knighti 1½x

Cardiomorpha missouriensis "Type A" 1x

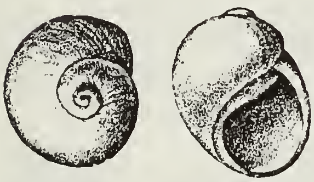
Cardiomorpha missouriensis "Type B" 1½x

GASTROPODS

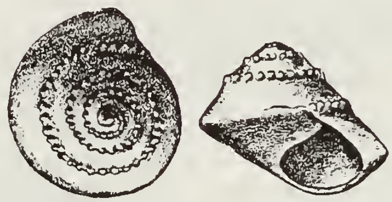
Euphemites carbonarius 1½x

Trepospira illinoisensis 1½x

Donaldina robusta 8x



Naticopsis (Jedria) ventricosa 1½x



Trepospira sphaerulata 1x

Knightites montfortianus 2x

Glabrocingulum (Glabrocingulum) grayvillense 3x

BRACHIOPODS

Wellerella tetrahedra 1½ x

Juresania nebrascensis 2/3 x

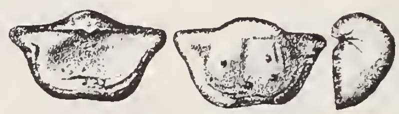
Derbya crassa 1 x

Composita argentia 1 x

Neospirifer cameratus 1 x

Chonetes granulifer 1½ x

Mesolobus mesolobus var. *euampygus* 2 x



Marginifera splendens 1 x

Crurithyris planoconvexa 2 x

Linoproductus "cora" 1 x

PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, an interval of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. The cooling of the earth's surface, a prerequisite for glaciation, began at least 2 million years ago. On the basis of evidence found in subpolar oceans of the world (temperature-dependent fossils and oxygen-isotope ratios), a recent proposal has been made to recognize the beginning of the Pleistocene at 1.6 million years ago. Ice sheets formed in sub-arctic regions many times and spread outward until they covered the northern parts of Europe and North America. In North America, early studies of the glacial deposits led to the model that four glaciations could explain the observed distribution of glacial deposits. The deposits of a glaciation were separated from each other by the evidence of intervals of time during which soils formed on the land surface. In order of occurrence from the oldest to the youngest, they were given the names Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. Work in the last 30 years has shown that there were more than four glaciations but the actual number and correlations at this time are not known. Estimates that are gaining credibility suggest that there may have been about 14 glaciations in the last one million years. In Illinois, estimates range from 4 to 8 based on buried soils and glacial deposits. For practical purposes, the previous four glacial stage model is functional, but we now know that the older stages are complex and probably contain more than one glaciation. Until we know more, all of the older glacial deposits, including the Nebraskan and Kansan will be classified as pre-Illinoian. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed when the mean annual temperature was perhaps 4° to 7°C (7° to 13°F) cooler than it is now and winter snows did not completely melt during the summers. Because the time of cooler conditions lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was enough to lower the sea level from 300 to 400 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the buried deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called **drift**. Drift that is ice-laid is called **till**. Water-laid drift is called **outwash**.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also stratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders. For descriptive purposes, a mixture of clay, silt, sand and boulders is called **diamicton**. This is a term used to describe a deposit that could be interpreted as till or a mass wasting product.

Tills may be deposited as **end moraines**, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as **ground moraines**, or **till plains**, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called **outwash**. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size—the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits in some places. In general, outwash tends to be coarser and less weathered, and alluvium is most often finer than medium sand and contains variable amounts of weathered material.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an **esker**. Some eskers in Illinois are made up of sandy to silty deposits and contain mass wasted diamicton material. Cone-shaped mounds of coarse outwash, called **kames**, were formed where meltwater plunged through crevasses in the ice or into ponds on the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake rapidly lost speed and also quickly dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were commonly redistributed on the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an **outwash plain**. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississiippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as **valley trains**. Valley train deposits may be both extensive and thick. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess, Eolian Sand and Soils

One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. **Loess** is the name given to windblown deposits dominated by silt. Most of the silt was derived from wind erosion of the valley trains. Wind action also sorted out **eolian sand** which commonly formed **sand dunes** on the valley trains or on the adjacent uplands. In places, sand dunes have migrated up to 10 miles away from the principle source of sand. Flat areas between dunes are generally underlain by eolian **sheet sand** that is commonly reworked by water action. On uplands along the major valley trains, loess and eolian sand are commonly interbedded. With increasing distance from the valleys, the eolian sand pinches out, often within one mile.

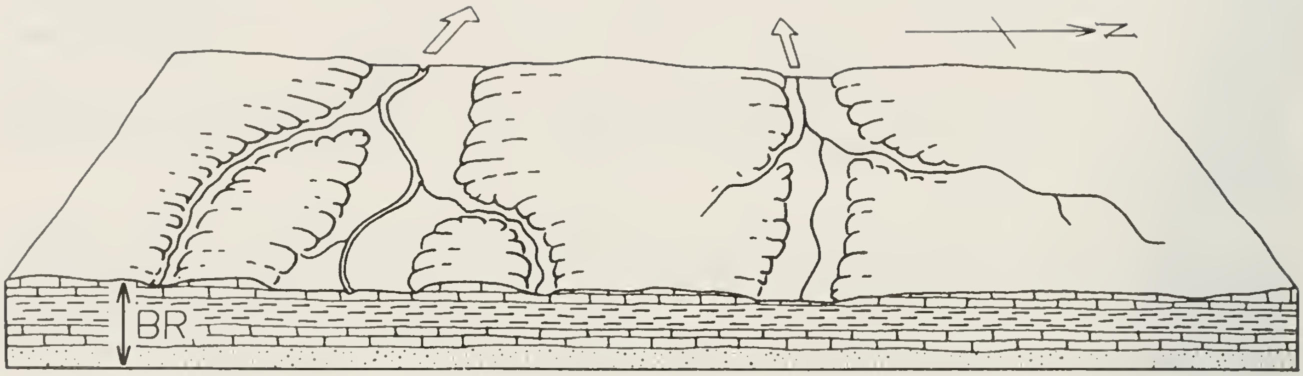
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but some were buried. Those that survive serve as “key beds,” or stratigraphic markers, and are evidence of the passage of a long interval of time.

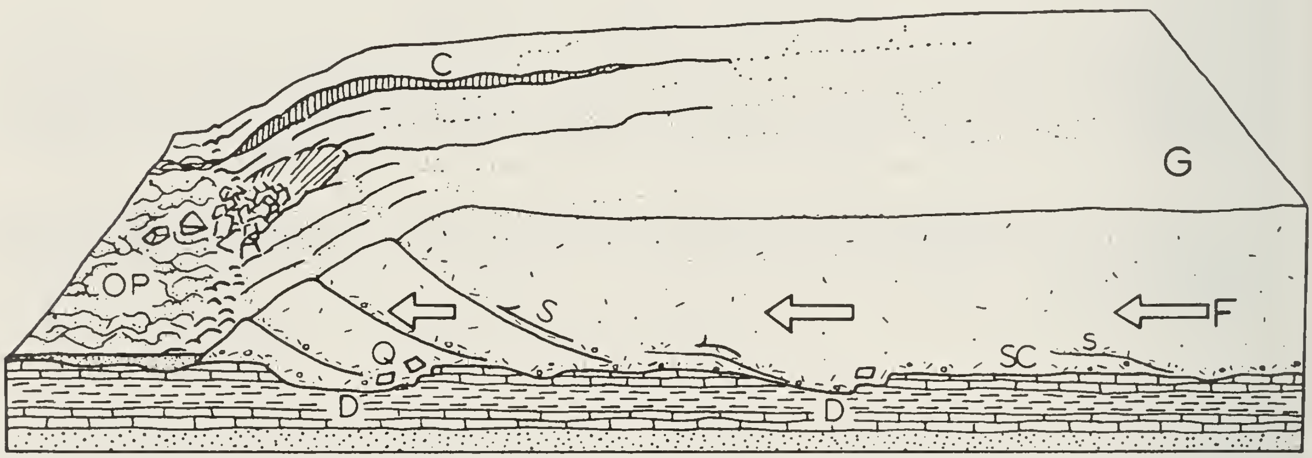
Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked at various stages as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

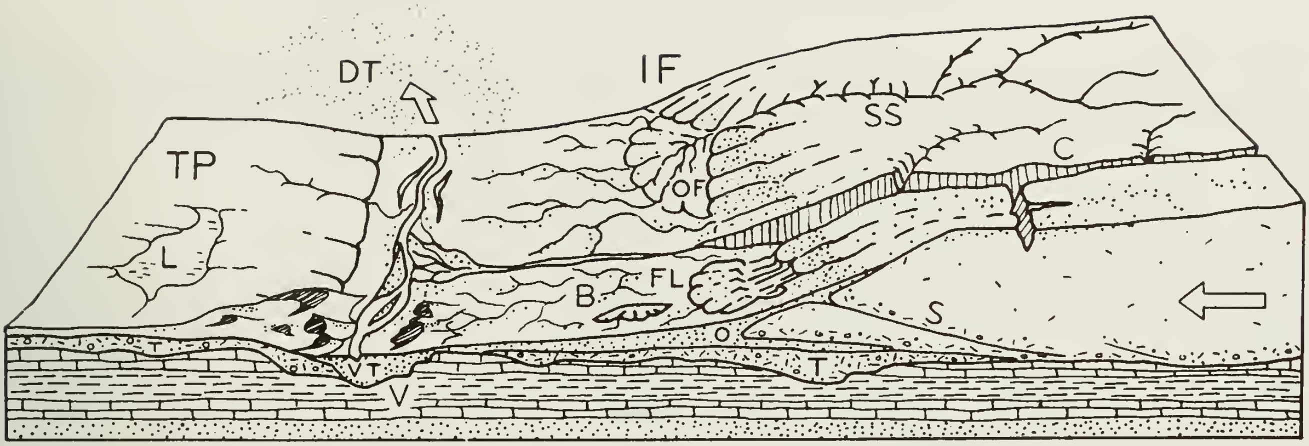
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



1. **The Region Before Glaciation** — Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks—layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



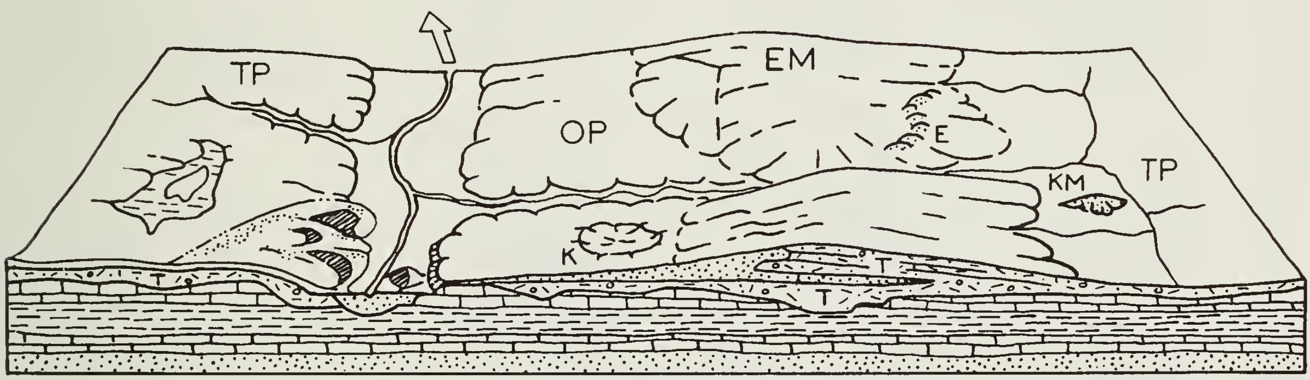
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, and tapers to the margin, which was probably in the range of several hundred feet above the old terrain. The ice front advances perhaps as much as a third of a mile per year.



3. **The Glacier Deposits an End Moraine** — After the glacier advances across the area, the climate warms and the ice begins to melt as fast as it advances. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that is mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A supraglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) remains as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remains a low spot in the terrain. As soon as the ice cover melts, meltwater drains down the valley, cutting it deeper. Later, outwash partly refills the valley: the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles. Sand dunes (D) form on the south and east sides of streams.



4. **The Region after Glaciation** — As the climate warms further, the whole ice sheet melts, and glaciation ends. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

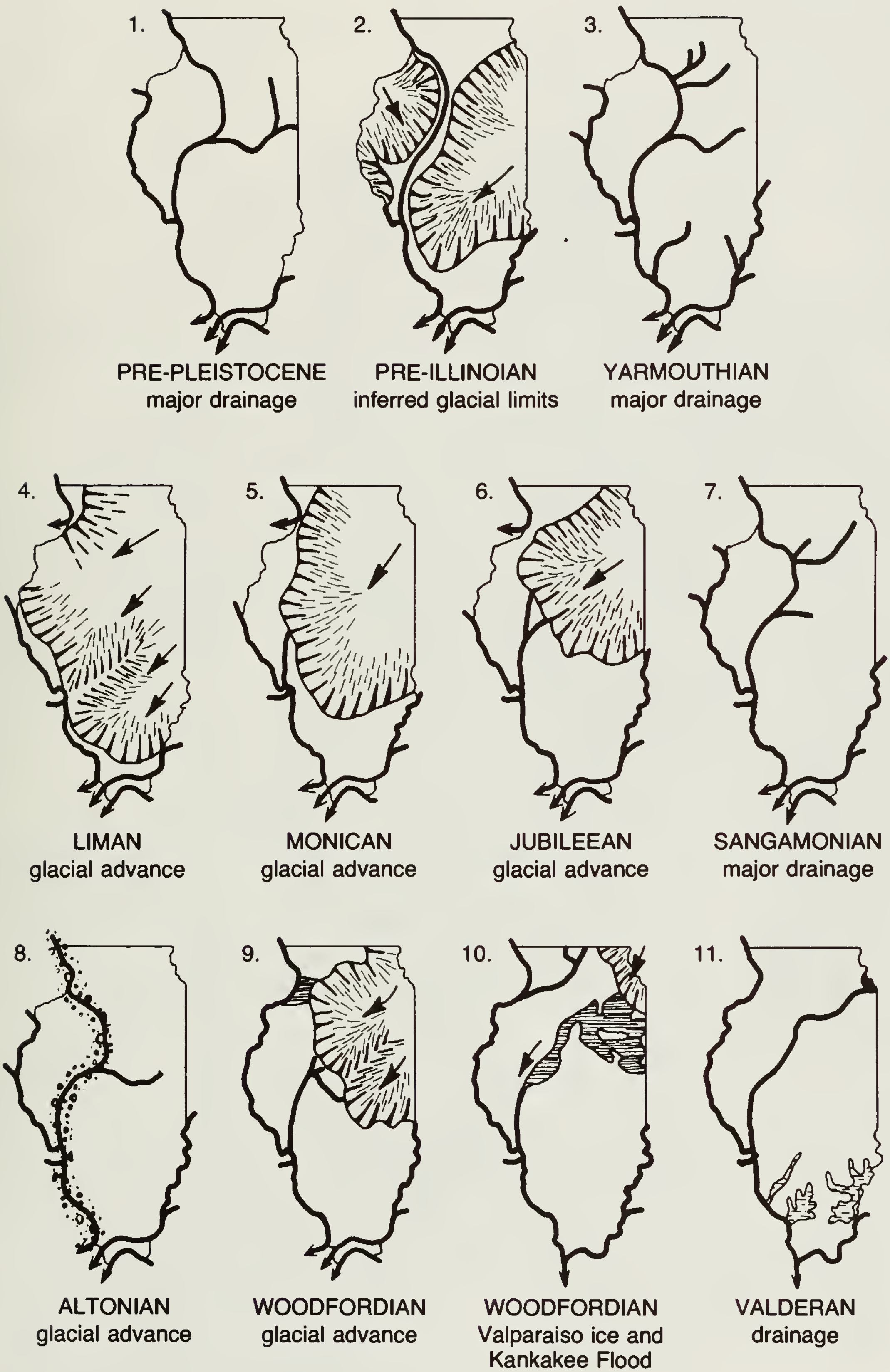
TIME TABLE OF PLEISTOCENE GLACIATION

		STAGE		SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
QUATERNARY		HOLOCENE (interglacial)		Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
				10,000		
	Pleistocene	WISCONSINAN (glacial)	late	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
				11,000		
				Twocreekan	Peat and alluvium	Ice withdrawal, erosion
				12,500		
				Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
				25,000		
			mid	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
				28,000		
			early	Altonian	Drift, loess	Glaciation in Great Lakes area, valley trains along major rivers
				75,000		
		SANGAMONIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
				125,000		
		ILLINOIAN (glacial)		Jubileean	Drift, loess, outwash	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
				Monican	Drift, loess, outwash	
				Liman	Drift, loess, outwash	
				300,000?		
		YARMOUTHIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
				500,000?		
	Pre-Illinoian	KANSAN* (glacial)			Drift, loess	Glaciers from northeast and northwest covered much of state
				700,000?		
		AFTONIAN* (interglacial)			Soil, mature profile of weathering	(hypothetical)
				900,000?		
		NEBRASKAN* (glacial)			Drift (little known)	Glaciers from northwest invaded western Illinois
				1,600,000 or more		

*Old oversimplified concepts, now known to represent a series of glacial cycles.

(Illinois State Geological Survey, 1973)

SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS

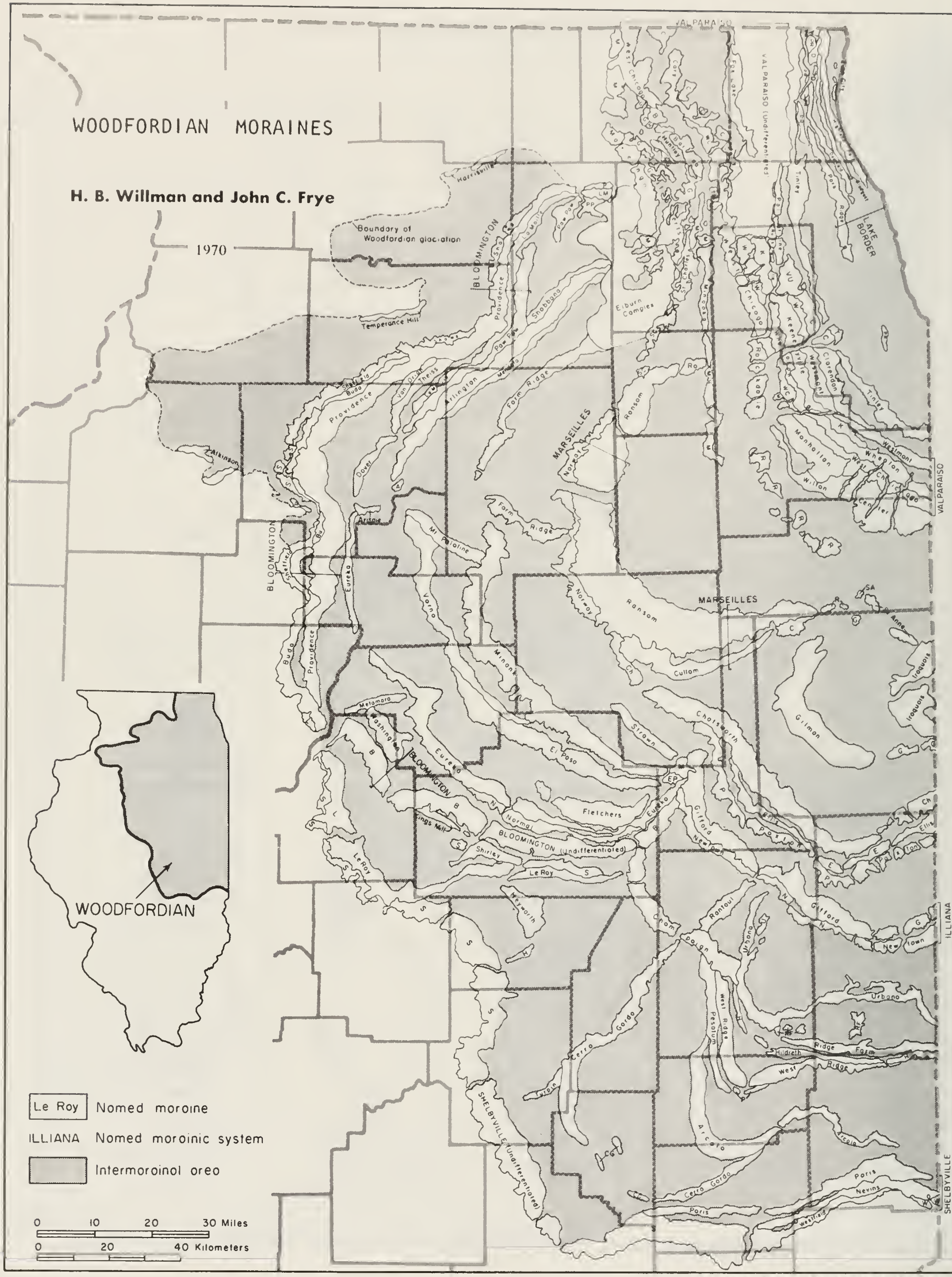


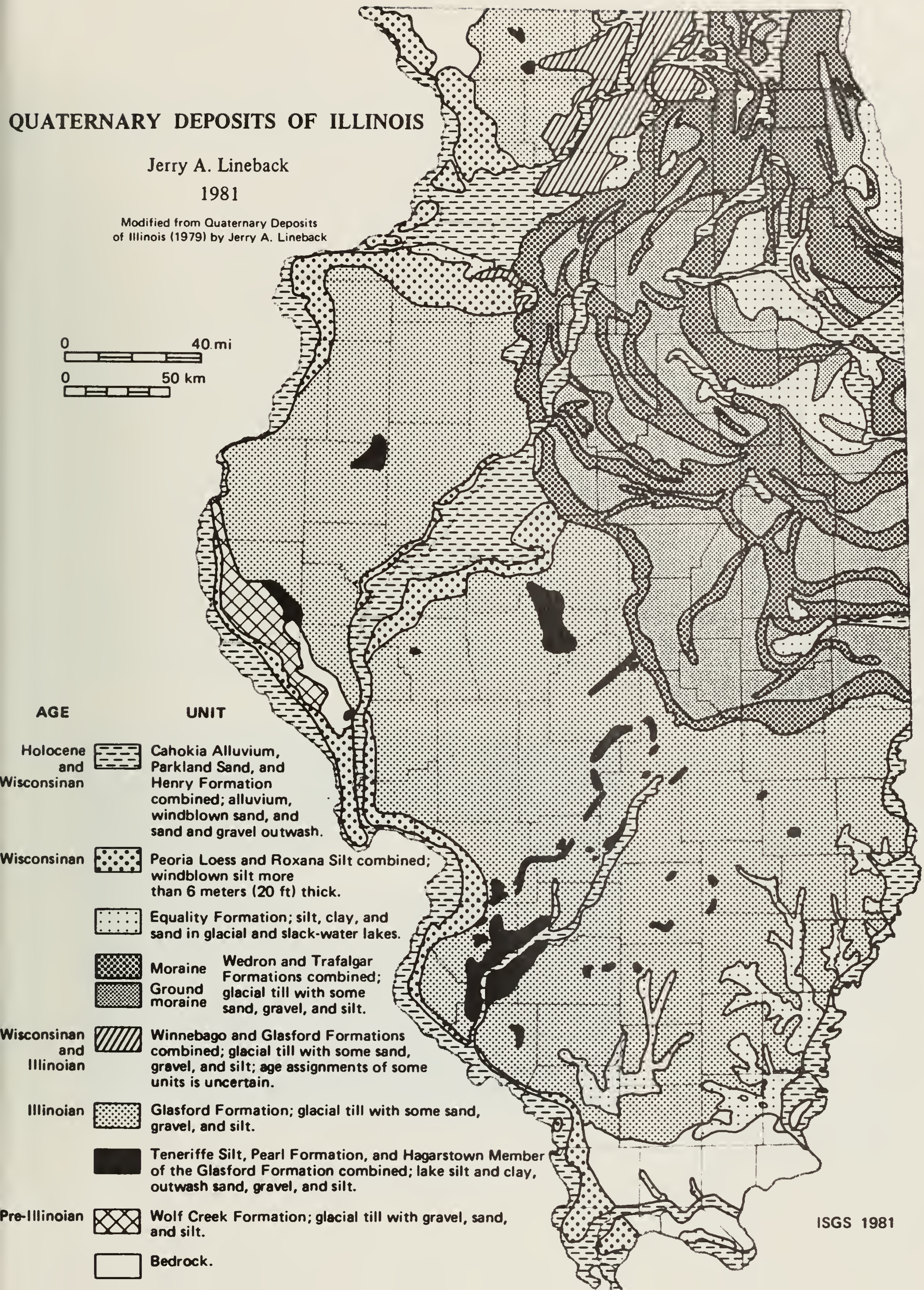
(Modified from Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)

WOODFORDIAN MORAINES

H. B. Willman and John C. Frye

1970




QUATERNARY DEPOSITS OF ILLINOIS
Jerry A. Lineback
1981
Modified from Quaternary Deposits of Illinois (1979) by Jerry A. Lineback
0
40 mi
0
50 km
AGE
UNIT
Holocene and Wisconsinan
Cahokia Alluvium, Parkland Sand, and Henry Formation combined; alluvium, windblown sand, and sand and gravel outwash.
Wisconsinan
Peoria Loess and Roxana Silt combined; windblown silt more than 6 meters (20 ft) thick.
Equality Formation; silt, clay, and sand in glacial and slack-water lakes.
Moraine
Ground moraine
Wedron and Trafalgar Formations combined; glacial till with some sand, gravel, and silt.
Wisconsinan and Illinoian
Winnebago and Glasford Formations combined; glacial till with some sand, gravel, and silt; age assignments of some units is uncertain.
Illinoian
Glasford Formation; glacial till with some sand, gravel, and silt.
Teneriffe Silt, Pearl Formation, and Hagarstown Member of the Glasford Formation combined; lake silt and clay, outwash sand, gravel, and silt.
Pre-Illinoian
Wolf Creek Formation; glacial till with gravel, sand, and silt.
Bedrock.
ISGS 1981

ILLINOIS STATE GEOLOGICAL SURVEY
Urbana, Illinois 61801

GEOGRAM 2
October 1974

ERRATICS ARE ERRATIC

Myrna M. Killey

You may have seen them scattered here and there in Illinois—boulders, some large, some small, lying alone or with a few companions in the corner of a field, at the edge of a road, in someone's yard, or perhaps on a courthouse lawn or schoolyard. Many of them seem out of place, like rough, alien monuments in the stoneless, grassy knolls and prairies of our state. Some—the colorful and glittering granites, banded gneisses, and other intricately veined and streaked igneous and metamorphic rocks—are indeed foreign rocks, for they came from Canada and the states north of us. Others—gray and tan sedimentary rocks—are native rocks and may be no more than a few miles from their place of origin. All of these rocks are glacial boulders that were moved to their present sites by massive ice sheets that flowed across our state. If these boulders are unlike the rocks in the quarries and outcrops in the region where they are found, they are called erratics.

The continental glaciers of the Great Ice Age scoured and scraped the land surface as they advanced, pushing up chunks of bedrock and grinding them against each other or along the ground surface as the rock-laden ice sheets pushed southward. Hundreds of miles of such grinding, even on such hard rocks as granite, eventually rounded off the sharp edges of these passengers in the ice until they became the rounded, irregular boulders we see today. Although we do not know the precise manner in which erratics reached their present isolated sites, many were probably dropped directly from the melting front of a glacier. Others may have been rafted to their present resting places by icebergs on ancient lakes or on the floodwaters of some long-vanished stream as it poured from a glacier. Still others, buried in the glacial deposits, could have worked their way up to the land surface as the surrounding loose soil repeatedly froze and thawed. When the freezing ground expands, pieces of rock tend to be pushed upward, where they are more easily reached by the farmer's plow and also more likely to be exposed by erosion.

An eight-foot boulder of pink granite left by a glacier in the bed of a creek about 5 miles southwest of Alexis, Warren County, Illinois. (From ISGS Bulletin 57, 1929.)

Generally speaking, erratics found northeast of a line drawn from Freeport in Stephenson County, southward through Peoria, and then southeastward through Shelbyville to Marshall at the east edge of the state were brought in by the last glacier to enter Illinois. This glaciation, called the Wisconsinan, spread southwestward into Illinois from a center in eastern Canada, reaching our state about 75,000 years ago and (after repeated advances and retreats of the ice margin) melting from the state about 12,500 years ago. Erratics to the west or south of the great arc outlined above were brought in by a much older glacier, the Illinoian, which spread over most of the state about 300,000 to 175,000 years ago. Some erratics were brought in by even older glaciers that came from the northwest.

You may be able to locate some erratics in your neighborhood. Sometimes it is possible to tell where the rock originally came from by determining the kind of rock it is. A large boulder of granite, gneiss, or other igneous or metamorphic rock may have come from the Canadian Shield, a vast area in central and eastern Canada where rocks of Precambrian age (more than 600 million years old) are exposed at the surface. Some erratics containing flecks of copper were probably transported here from the "Copper Range" of the upper peninsula of Michigan. Large pieces of copper have been found in glacial deposits of central and northern Illinois. Light gray to white quartzite boulders with beautiful, rounded pebbles of red jasper came from a very small outcrop area near Bruce Mines, Ontario, Canada. Purplish pieces of quartzite, some of them banded, probably originated in the Baraboo Range of central Wisconsin. Most interesting of all are the few large boulders of Canadian tillite. Tillite is lithified (hardened into rock) glacial till deposited by a Precambrian glacier many millions of years older than the ones that invaded our state a mere few thousand years ago. Glacial till is an unsorted and unlayered mixture of clay, sand, gravel, and boulders that vary widely in size and shape. Tillite is a gray to greenish gray rock containing a mixture of grains of different sizes and scattered pebbles of various types and sizes.

Many erratics are of notable size and beauty, and in parts of Illinois they are commonly used in landscaping. Some are used as monuments in courthouse squares, in parks, or along highways. Many are marked with metal plaques to indicate an interesting historical spot or event. Keep an eye out for erratics. There may be some of these glacial strangers in your neighborhood that would be interesting to know.

ANCIENT DUST STORMS IN ILLINOIS

Myrna M. Killey

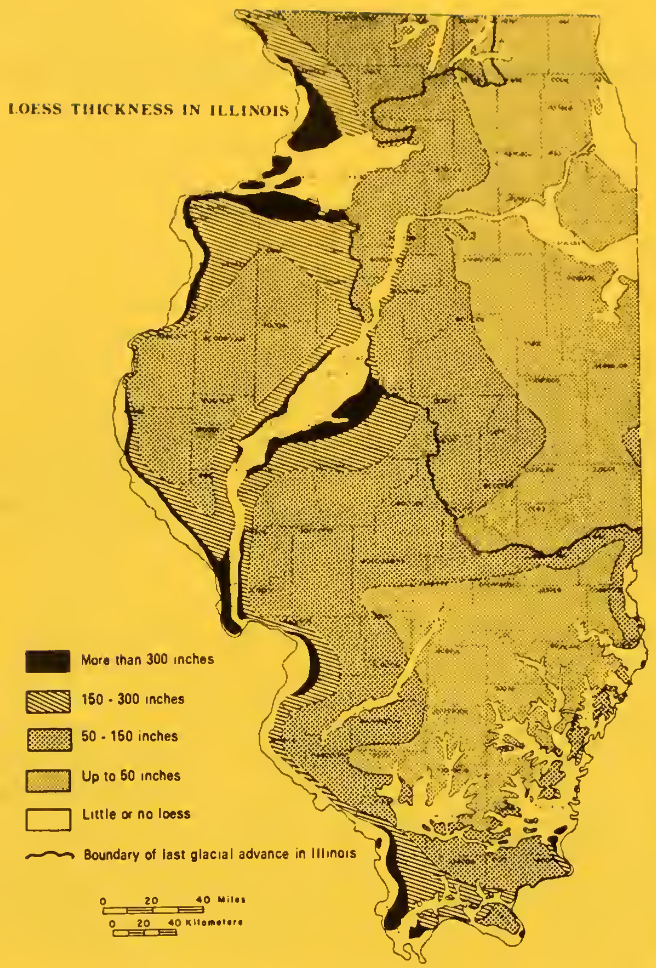
Fierce dust storms whirled across Illinois long before human beings were here to record them. Where did all the dust come from? Geologists have carefully put together clues from the earth itself to get the story. As the glaciers of the Great Ice Age scraped and scoured their way southward across the landscape from Canada, they moved colossal amounts of rock and earth. Much of the rock ground from the surface was kneaded into the ice and carried along, often for hundreds of miles. The glaciers acted as giant grist mills, grinding much of the rock and earth to "flour"—very fine dust-sized particles.

During the warm seasons, water from the melting ice poured from the glacier front, laden with this rock flour, called silt. In the cold months the meltwater stopped flowing and the silt was left along the channels the water had followed, where it dried out and became dust. Strong winds picked up the dust, swept it from the floodplains, and carried it to adjacent uplands. There the forests along the river valleys trapped the dust, which became part of the moist forest soil. With each storm more material accumulated until the high bluffs adjacent to major rivers were formed. The dust deposits are thicker along the eastern sides of the valleys than they are on the western sides, a fact from which geologists deduce that the prevailing winds of that time blew from west to east, the same direction as those of today. From such clues geologists conclude that the geologic processes of the past were much like those of today.

The deposits of windblown silt are called loess (rhymes with "bus"). Loess is found not only in the areas once covered by the glaciers but has been blown into the nonglaciated areas. The glaciers, therefore, influenced the present land surface well beyond the line of their farthest advance.

Loess has several interesting characteristics. Its texture is so fine and uniform that it can easily be identified in roadcuts—and because it blankets such a vast area many roads are cut through it. Even more noticeable is its tendency to stand in vertical walls. These steep walls develop as the loess drains and becomes tough, compact, and massive, much like a rock. Sometimes cracks develop in the loess, just as they do in massive limestones and sandstones. Loess makes good highway banks if it is cut vertically. A vertical cut permits maximum drainage because little surface is exposed to rain, and rainwater tends to drain straight down through it to the rock underneath. If the bank is cut at an angle more water soaks in, which causes the loess to slump down. Along Illinois roads the difference between a loess roadcut and one in ordinary glacial till is obvious. The loess has a very uniform texture, while the till is composed of a random mixture of rock debris, from clay and silt through cobbles and boulders.

Many loess deposits are worth a close look. Through a 10-power hand lens separate grains can be seen, among them many clear, glassy, quartz grains. Some loess deposits contain numerous rounded, lumpy stones called concretions. Their formation began when water percolating through the loess dissolved tiny

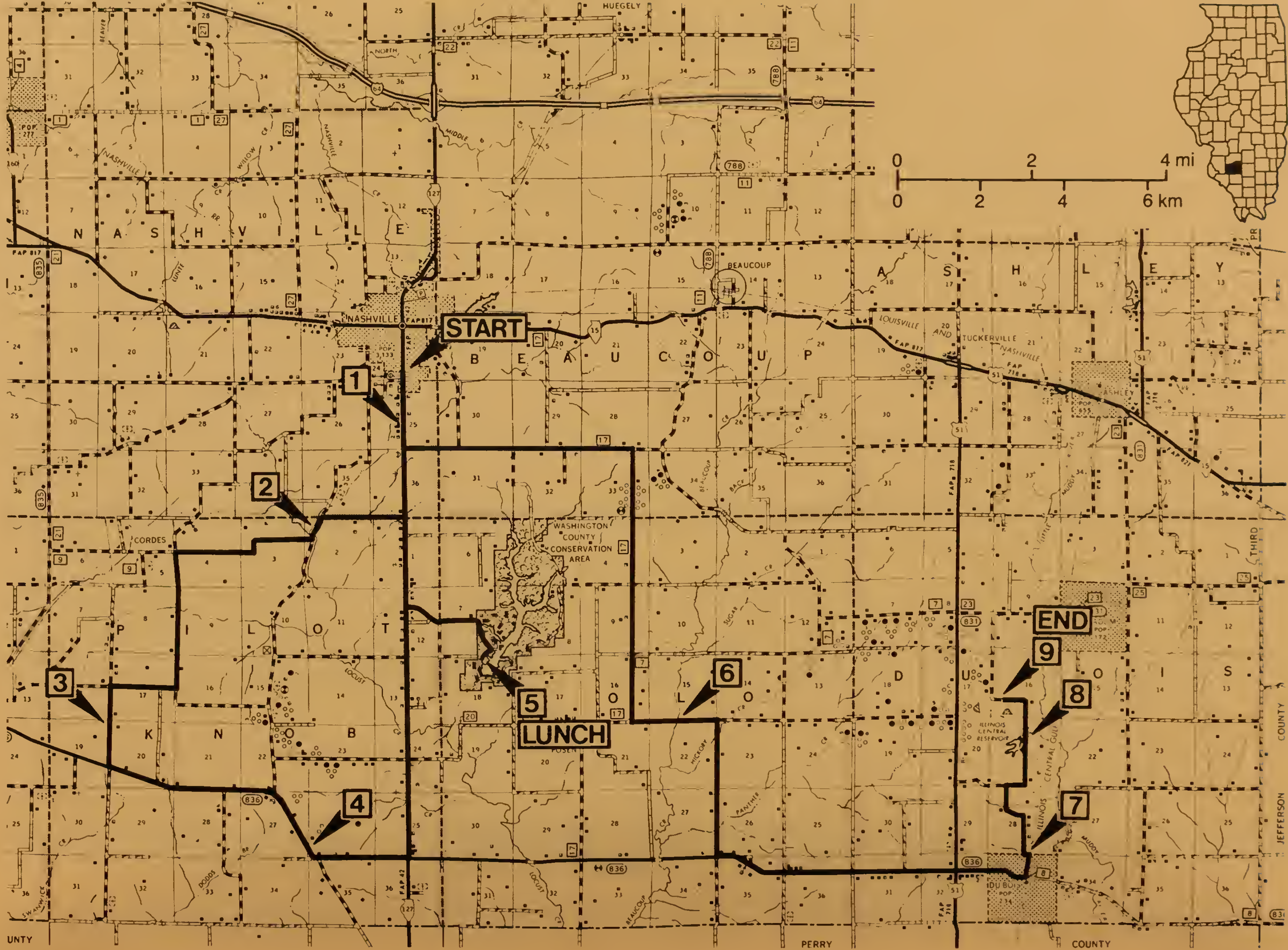


limestone grains. Some of the dissolved minerals later became solid again, gathering around a tiny nucleus or along roots to form the lumpy masses. A few such concretions are shaped roughly like small dolls and, from this resemblance, are called "loess kindchen," a German term meaning "loess children." They may be partly hollow and contain smaller lumps that make them rattle when shaken.

Fossil snails can be found in some loess deposits. The snails lived on the river bluffs while the loess was being deposited and were buried by the dust. When they are abundant, they are used to determine how old the loess is. The age is found by measuring the amount of radioactive carbon in the calcium carbonate of their shells.

Some of the early loess deposits were covered by new layers of loess following later glacial invasions. Many thousands of years passed between the major glacial periods, during which time the climate was as warm as that of today. During the warm intervals, the surface of the loess and other glacial deposits was exposed to weather. Soils developed on most of the terrain, altering the composition, color, and texture of the glacial material. During later advances of the ice, some of these soils were destroyed, but in many places they are preserved under the younger sediments. Such ancient buried soils can be used to determine when the materials above and below them were laid down by the ice and what changes in climate took place.

The blanket of loess deposited by the ancient dust storms forms the parent material of the rich, deep soils that today are basic to the state's agriculture. A soil made of loess crumbles easily and has great moisture-holding capacity. It also is free from rocks that might complicate cultivation. Those great dust storms that swirled over the land many thousands of years ago thus endowed Illinois with one of its greatest resources, its highly productive soil.



START
LUNCH
END
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NASHVILLE
BEAUCOUP
HUEGELY
CORDES
TUCKERVILLE
ASHLEY
DU BOIS
WASHINGTON COUNTY CONSERVATION AREA
ILLINOIS CENTRAL RESERVOIR
PERRY COUNTY
JEFFERSON COUNTY
0 2 4 mi
0 2 4 6 km